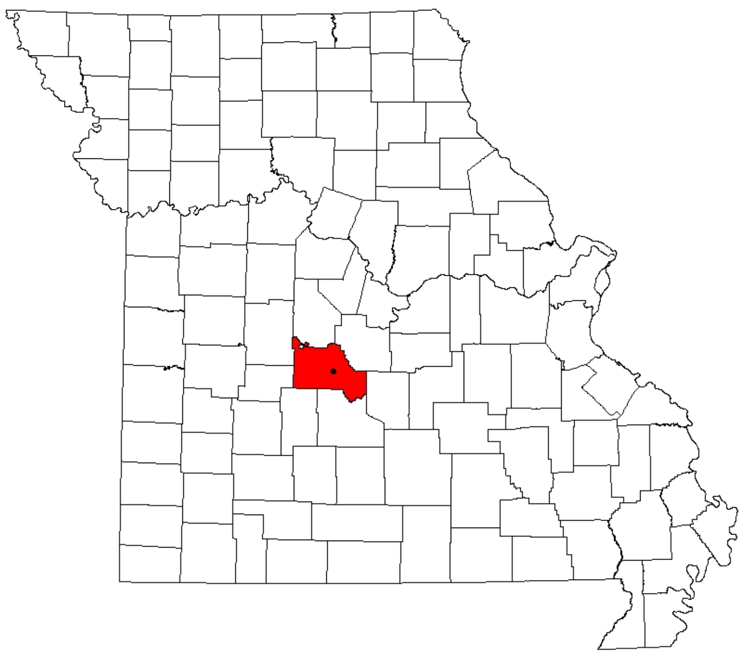
SITE REASSESSMENT REPORT

Camdenton Sludge Disposal Area Site
Camden County, Missouri

March 11, 2019



MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

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DATE: March 11, 2019
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SITE: Camdenton Sludge Disposal Area, Camden County
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1.0 INTRODUCTION

Under the authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Missouri Department of Natural Resources (Department), through a cooperative agreement with the U.S. Environmental Protection Agency (USEPA), conducted a Site Reassessment (SR) at the Camdenton Sludge Disposal Area Site in Camden County, Missouri.

The Camdenton Sludge Disposal Area site is a 40 acre portion of the City of Camdenton Memorial-Lake Regional Airport (KOZS) where over 2,000 cubic feet of sludge wastes from a residential/industrial wastewater treatment lagoon were disposed of in 1989. The sludge originated from the City Lagoon #3 (formerly known as Hulett Lagoon) (EPA ID No MOSFN0703530) which operated from 1961 to 1989 and accepted municipal sewage and industrial waste from a manufacturing facility located at 221 Sunset Drive (Modine Manufacturing Co., EPA ID No. MOD062439351) (MDNR, 1999, Wilder, 1999c). The industrial waste contained trichloroethylene (TCE) and dissolved metals. The City Lagoon #3 was closed in 1989 when the lagoon was dewatered and the sludge was removed for transport and disposal. The Department's Water Protection Program permitted the disposal of the sludge at the Camdenton Memorial Airport after testing to confirm that metals concentrations did not exceed USEPA regulatory thresholds (Friese, 1988, Friese, 1989).

The Department completed a Combined Preliminary Assessment/Site Inspection (PA/SI) investigation for the Camdenton Sludge Disposal Area site in 1999 and concluded that no further CERCLA assessment was warranted at that time. Soil borings conducted by the Department encountered the sludge on site and testing revealed that it did not contain TCE. Private and public

wells within one quarter mile were sampled for volatile organic compounds (VOC) and metals content during the PA/SI and no contaminants above health based levels of concern were detected.

The current Site Reassessment investigation was initiated in response to citizen concerns that area groundwater was impacted by the sludge disposal area, and allegations that additional locations besides airport had been used as sludge disposal sites (Burns, 2017). The Department initiated the Site Reassessment investigation on June 30, 2017 to examine whether the site poses a threat to human health through the groundwater/drinking water exposure pathway.

The purpose of this investigation was to collect sufficient information concerning conditions at the site to assess the threat posed to human health and the environment through the groundwater/drinking water pathway. The scope of the investigation included a review of available file information, and collection and analysis of groundwater sampling data from public and private wells surrounding the site. Investigation activities included sampling events on October 2, 2017, October 19, 2017, and February 13, 2018.

2.0 SITE DESCRIPTION

2.1 Location

The Camdenton Sludge Disposal Area site is located on County Road 5-120 in the southeast portion of the Camdenton Memorial Airport property. The site is located on city property three miles southeast of Camdenton city limits (Figure 1). The geographic coordinates of the site as measured from the field where the sludge was applied are 37.968892 latitude and -92.687353 longitude. The sludge disposal area was identified at the southeast side of the airport; however in 2002 a portion of the original disposal area was covered by pavement during an expansion of the runway (Mroczka, 2016, Coleman, 2017). The site is approximately four miles from three other sites in Camdenton with known soil and/or groundwater (TCE) contamination; City Lagoon #3 (where the sludge originated), 221 Sunset Drive former manufacturing facility (formerly operated by Dawson Metal Products, Sundstrand and Modine Manufacturing Co.), Dawson Metal Products Camdenton Facility #2 (Figure 2).

Directions to the site are as follows: From Jefferson City take U.S. Highway 54 West for 56 miles (traveling west and south) from the intersection of U.S. Highway 54 and State Route 5 in Camdenton by taking State Route 5 southeast for 4.4 miles to County Road 5-120; take a left onto CR 5-120 (portions of which are unimproved road) and travel east. The disposal area is 0.3 of a mile down the road on the north side.

Camden County has a temperate climate with cold winters and hot summers. The Camdenton area receives an average of 42.32 inches of precipitation annually, and an average of 19 inches of snowfall annually (USDC, 1961. The maximum expected two-year, 24-hour rainfall is approximately 3.5 inches (USDC, 1968). The average daily temperature during the summer months is 77° F, and the average winter temperature is 35° F (USDA, 1994). The average wind speed and direction is approximately 10 miles per hour from the south (USDC, 1968).

2.1.2 Site Description

The site is located south of Camdenton, a community of 3,718 residents (USCB, 2017), in a semi-rural portion of Camden County in central Missouri. The site consists of an open field adjacent to the landing strip of the Camdenton Municipal Airport where sludge from the City Lagoon #3 was applied in 1989 (Figure 1). A portion of the original site has been covered up during extension of the airport runway. The airport property can be accessed through 20 Airport Road and other than this entrance, the site is completely fenced to prevent trespassers and livestock from accessing the runway.

At the time of disposal, 42.4 acres were set aside for the sludge application; however, the actual area of sludge disposal was reportedly less than 42 acres (Wilder, 1999a). The sludge disposal area consisted of a designated circular stockpiling area with a two-foot perimeter berm located approximately 150 feet from the county road, and two designated field areas that were to be used for disposal (Figures 3 and 6 in Appendix A) (MEC, 1989). The outline of the stockpiling area was faintly discernable at the time of the 1999 PA/SI. Most drainage for the site flows into a low ditch that runs west to east across the southern portion of the site (Wilder, 1999b).

The actual area where sludge was disposed of is located on a flat, mowed grassy area near the runway and likely now includes an area covered by the runway as well. The area that received the sludge material are not visibly distinguishable from the surrounding mowed grass, but several soil cores collected during the 1999 PA/SI investigation featured an atypical green-grey hue indicative of sludge material which may still be identifiable at depth on site (Wilder, 1999a).

The surrounding area consists of residential properties along with commercial and public service buildings. The landscape is dominated by pastures and forests with homes clustered along the county maintained roadways. The site itself is virtually flat and there are no trees or other woody vegetation in the immediate vicinity. The site is located on a plain atop a broad ridgeline running roughly north-south with drainage features flowing to the east and west into the Lake of the Ozarks (Elfrink, 1999, Bachle, 2017a).

2.2 Operational and Site History

The site is a field on the municipal airport for the City of Camdenton officially known as the Camdenton Memorial –Lake Regional Airport (KOZS). Regional flights serve the Lake of the Ozarks regional area. In 1989, the City of Camdenton land-applied sewage sludge from the City Lagoon #3 which received a mix of domestic wastewater and industrial waste from a metal parts manufacturing facility at 221 Sunset Drive. The waters and sludge from the City Lagoon #3 have been found to contain VOCs and metals (Tables 1 and 2). The sludge was applied to an area at the south end of the airport south and east of the runway. A 2002 airport expansion project likely covered a portion of the sludge disposal area soils under asphalt. Further extension of the runway to accommodate larger aircraft is planned in 2018-2019 (Mroczka, 2016).

The City Lagoon #3 is the source for sludge placed at the Camdenton Sludge Disposal Area and the following description of the City Lagoon #3 is included to provide pertinent background information.

The City of Camdenton’s City Lagoon #3 was constructed in 1961 under the State of Missouri Grants Program. City Lagoon #3 was most commonly referred to as the Hulett Lagoon due to its proximity to the Ron Hulett automobile dealership that is located at 249 N. Highway 5 (Wilder,

1999c). The lagoon was also referred to as the Factory Lagoon and by the official name of City Lagoon #3 used here (MEC, 1989, Wilder, 1999c).

Camdenton's City Lagoon #3 operated from 1961 to 1988. From 1967 through 1986 the manufacturing facility located at 221 Sunset Drive approximately 1,000 feet southeast of the lagoon, released untreated wastewater and storm water into the lagoon through a series of "mudpits", or sumps, via a storm sewer (MDNR, 1992). Air conditioning coils were manufactured at the 221 Sunset Drive facility first by Dawson Metal Products (1970-1972), next by Sundstrand Tubular Products (who bought Dawson in 1972 and operated until 1990), and finally by Modine Manufacturing (1990- 2012). Untreated wastewater discharged from the facility was known to have contained several hazardous waste streams including corrosive waste, wastewater treatment sludge from electroplating operations, and waste oil. In addition, residual contaminants associated with degreasing operations, including TCE, were discharged into the mud pits and ultimately into the City Lagoon #3 (Wilder, 1999a). While the TCE and heavy metal contamination originated from the facility at 221 Sunset Drive in Camdenton, the wastes themselves only came under CERCLA jurisdiction after mixing with municipal sewage rendered them exempt from Resource Conservation and Recovery Act (RCRA) regulations.

In 1988, the City of Camdenton began closure of the City Lagoon #3 pursuant to an Industrial Development Grant overseen by Department's Water Pollution Control Program. As per Department guidelines for closing out municipal lagoons, sampling and analysis of the sludge in the lagoon was limited to metals (Al, Cr, Cd, Cu, Pb, Ni, and Zn) and other parameters such as total solids. High levels of chromium, lead, and nickel were detected. The city opted to perform subsurface application by spreading the dried sludge and disking it into the soil. DNR approved the sludge disposal plan on February 22, 1989 (Wilder, 1999a).

The city's engineering consultant, Missouri Engineering Corporation, supervised the lagoon closure project. The contract included specifications for lagoon dewatering, preparation, transportation, and stockpiling of the sludge, as well as disposal by land application. When that portion of the project was completed, an estimated 2,395 cubic yards of sludge had been removed (Cyrus, 1989; McCormick, 1989, Hixson, 1990). The sludge was applied at the Camdenton

Municipal Airport from July 1989 through March 1990. City employees who observed some of the spreading activity reported the sludge was more difficult to spread evenly than was originally anticipated. It didn't dry out completely and would stick together in clumps. Near the end of the process, it was reported that the last several piles of sludge transported to the area were simply dumped into the ditch located about 50 feet north of the circular storage area (Wilder, 1999b). It was not spread, mixed or disked. In March 1990, the land application field was seeded to provide ground cover and prevent erosion.

2.2.2 Allegations of Additional Sludge Disposal Locations

Reports from a concerned citizen were received by the Department on June 20, 2017 suggesting that additional properties aside from the Camdenton Memorial Airport had received waste from the City Lagoon #3 closure in 1989 (Burns, 2017). Department staff did not find evidence to support these claims. Department staff interviewed landowners that had allegedly receiving these wastes, and the property owners confirmed that the sludge they had accepted were from the city's C. P White Lagoon rather than from the City Lagoon #3 (Coleman, 2017, Tidgren, 2017). Current and former City of Camdenton employees also corroborated that there were no additional sludge disposal sites for the City Lagoon #3 wastes (Emry, 2017). Furthermore, the timeline over which the landowners in question had accepted sludge on their properties (late 1990's- early 2000's) had occurred long after the closure of City Lagoon #3 and must have originated from other sources.

2.3 Previous Investigations

2.3.1 Former Hulett Lagoon (City Lagoon #3) Combined PA/SI 1999

Due to concerns about residual hazardous waste contamination at the closed City Lagoon #3, the Department completed a Combined PA/SI investigation of the City Lagoon #3 on March 30, 1999 (Wilder, 1999c).

To characterize condition within the closed lagoon site the Department's Environmental Service Program (ESP) personnel advanced 10 soil borings (Hulett-01 through Hulett-10) utilizing a track-mounted hydraulic soil probe. Eight soil grab samples were collected from the lagoon area and

one background sample was collected from outside the lagoon. Figure 2 shows the location of all soil samples collected in the lagoon area during the 1999 PA/SI investigation. All soil samples were analyzed for total metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, and silver) and VOCs (Wilder 1999c).

Table 2, in Appendix B, presents the analytical results for all soil samples collected by the Department as part of the Hulett Lagoon PA/SI. Three soil samples from the Hulett Lagoon 1999 sampling contained TCE at a detectable level. The concentrations of TCE detected in the three samples from the lagoon exceed the C_{LEACH} value for TCE, which would indicate potential existed for TCE to leach into the saturated zone and result in groundwater contamination above the MCL (MDNR, 1998, Wilder, 1999c). Only one sample from Hulett-04 contained any metals significantly above background. Barium and cadmium were over three times the background levels; however neither metal was present above the SCDM benchmarks or MO ASLs (screening levels at the time) (Table 2).

The 1999 Hulett Lagoon PA/SI concluded that a release of TCE to the Ozark aquifer had occurred from the site. Although the lagoon sludge was removed during closure, residual TCE concentrations were detected in soil near the outfall of the lagoon and in shallow groundwater monitoring wells. To address public concerns regarding potential TCE contamination in Camdenton permanent soil gas monitors were installed on site and soil gas sampling was conducted in February, May and August 2018 by Sundstrand /UTC contractors. Soil gas sampling results from 2018 indicate that, while TCE vapors are present in soils in the area immediately around the former lagoon, the concentration of TCE soil vapor diminishes in samples collected further from the site. Additional soil gas sampling is planned in 2019 to further characterize the extent of TCE soil vapor on site.

2.3.2 Camdenton Sludge Disposal Area Combined PA/SI 1999

In response to residents' concerns about potential contamination the City of Camdenton collected a groundwater sample from a drinking water well on August 3, 1998 located at a residence (later designated 3499 RR3) off of Forbes Road approximately 0.15 of a mile west-southwest of the Camdenton Sludge Disposal site. The sample was sent to the Department's ESP laboratory for

VOC analysis and 13.1 ppb TCE and 0.6 ppb cis-1,2-dichlorothene were detected (Wilder, 1999a). The City of Camdenton collected a second confirmatory sample from the well at 3499 RR3 on August 23, 1998 after purging the lines for at least 20 minutes and had it analyzed at the Department's laboratories. The sample collected on August 23 was non-detect for all VOCs (Wilder, 1999a).

Concern over potential VOC contamination in the local aquifer following these results prompted the Department to conduct a PA/SI of the Camdenton Sludge Disposal Area site. Source samples of sludge material were collected on January 22, 1999 and although analysis showed that there was metals present above background levels, the concentrations were below relevant cleanup standards. No TCE was detected in source sludge samples collected on site. The sludge disposal area is within the fenced property of the Camdenton Memorial Airport adjacent to an active runway and exposure to surface soils by the public is highly unlikely.

Groundwater samples for the PA/SI were collected on January 6 and 29, 1999. One public water supply well and three private drinking water wells were sampled. Figure 4 in Appendix A shows sample locations for all groundwater samples collected as part of the Camdenton Sludge Disposal PA/SI (Allen, 1999). Sample collection and results from the 1999 PA/SI are summarized below.

2.3.2.1 Department Source Area Sampling - January 22, 1999 (Allen, 1999)

The sludge disposal area was sampled on January 22, 1999 (Figure 5). Ten soil borings (Hulett-11 through Hulett-20) were drilled to collect eight soil/waste source samples from the sludge disposal area and two background samples from outside the area. A membrane interface probe (MIP) equipped with a photo ionization detector (PID) and a flame ionization detector (FID) was employed to generate soil gas data of the subsurface within the sludge disposal area and aid in selection of sampling locations. Small detections on the MIP's PID and FID in borings Hulett 12, 18, and 19 indicated volatile organic compounds were present (Allen, 1999). Surface (0.5'-1') and subsurface samples (5'-8') were collected to locate actual sludge material and attempt to determine whether any contaminants from the sludge may have migrated downward. The background boring was drilled just north of Forbes Road approximately 25 feet southwest of the sludge disposal area.

Table 3, in Appendix B, presents selected analytical results for all soil/waste samples. Source samples were analyzed for VOCs. TCE was not detected in any of the sludge (or soil) samples collected in the PA/SI.

All samples were analyzed for total metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, and silver) (chemical analytes not-detected in all samples are not listed in Table 3). Green sludge material was encountered in borings Hulett 12 and Hulett 19 from the ditch area. Analytical results from samples 991478 (Hulett 12) and 991483 (Hulett 19) from 0.5'-1' depths showed total levels of chromium, copper, lead, mercury (only in 991478) and nickel (only in 991483) significantly above background. The chromium, copper, and arsenic concentrations exceeded SCDM benchmarks, although it is notable that the arsenic concentrations were less than three times background levels and therefore do not constitute a release to the environment under CERCLA. While chromium was detected at 7,830 mg/kg in Hulett-19 and 1,640 mg/kg in Hulett 12, these concentrations are well below the 180,000mg/kg chromium EPA Regional Screening level which would require cleanup for an industrial site (and below the 120,000 mg/kg chromium EPA Regional Screening Level for residential sites). Ethylbenzene, toluene, and total xylenes were detected in sample 991483 and ethylbenzene was detected at depth in sample 991482 all at levels below levels which would require a cleanup (Wilder, 1999a).

2.3.2.2 Department Groundwater Sampling - January 6, 1999 (Allen, 1999)

Two samples were collected from the private drinking water well at 3499 RR3 on Forbes Road using a 30 second and a 5 minute purge time in an attempt to account for the discrepancy in analytical results in previous samples collected using different evacuation times. The samples were analyzed by the Department laboratory which did not detect any VOCs (including TCE) or metals above screening levels. Later in the day on January 6, an additional water sample was collected by private citizens from the well at 3499 RR3 for independent VOC analysis by Environmental Analysis South, Inc. in Cape Girardeau, MO. The private laboratory analysis showed 20 parts per billion (ppb) TCE from the well sample at 3499 RR3.

The well at the 3496 RR3 residence, located on Forbes Road (approximately 0.25 of a mile southeast of the site) was sampled by the Department on January 6, 1999, and was analyzed by the Department for total metals (arsenic, barium, cadmium, chromium, copper, mercury, nickel, lead, selenium, silver) and VOCs. The sample was non-detect for all VOCs (including TCE). Sample results for metals were below all relevant screening levels except for lead which was quantified at 17.7 (thus exceeding the National Secondary Drinking Water Regulation recommended limit of 15 ppb lead). The well was also sampled privately later on January 6, 1999, and analyzed for VOCs by a private laboratory which found 21ppb TCE.

The third well sampled by DNR on January 6, 1999, was at the residence located directly across the road from the 3496 RR3 (County Road 5-120) residence (labeled as “Private Well” on PA/SI groundwater sample map). Sample 991457, collected by Department staff from the private well at the residence across the road from 3496 RR3 was analyzed for total metals (arsenic, barium, cadmium, chromium, copper, mercury, nickel, lead, selenium, silver) and VOCs. No metals were detected at concentrations above relevant screening levels and the sample was non-detect for all VOCs.

2.3.2.3 Department Groundwater Sampling - January 29, 1999 (Allen, 1999)

Additional sampling was conducted at the 3496 and 3499 RR3 wells due to the discrepancies in analytical results from the samples collected on January 6, by the property owner and analyzed by Environmental Analysis South, Inc., and those collected and analyzed by the Department.

Due to theories that the TCE was only being detected after a certain amount of purging, several samples were collected from each well at various intervals of evacuation. Samples were collected from the well at 3499 RR3 at the following intervals of evacuation: 15 minutes, 45 minutes and 75 minutes. Samples were analyzed by the Department and split samples were analyzed by two separate private laboratories (Environmental Analysis South, Inc. and Environmental Health Laboratory). No VOCs were detected in any of the samples from 3499 RR3 at the Department’s laboratory or either of the private laboratories.

Four samples were collected from the well at 3496 RR3 at the following intervals of evacuation: 15 seconds, 15 minutes, 45 minutes and 75 minutes. Samples were analyzed by the Department and split samples were analyzed by two separate private laboratories (Environmental Analysis South, Inc. and Environmental Health Laboratory). No VOCs were detected in any of the samples from 3499 RR3 at the Department's laboratory or either of the private laboratories (Warren, 1999, Wilder, 1999a).

Also sampled on January 29, 1999, was the Camden County PWSD #2 Well #1. One sample, 991496, was collected from the well for VOCs after evacuating the well for 10 minutes. No VOCs were detected.

2.4 Waste Characteristics

2.4.1 Trichloroethylene -TCE

The primary contaminant of concern for the Camdenton Sludge Disposal Area is trichloroethylene (TCE); a manmade VOC. Records indicate that the sludge from City Lagoon #3 likely contained TCE, although state regulations at the time only required testing of metals contamination and quantitative data on the TCE concentration of the sludge is not available.

The following summary is based on information provided in the Toxicological Profile for TCE (ATSDR, 1996, ATSDR, 2015). TCE is a colorless liquid at room temperature that is nonflammable and has a somewhat slightly sweet odor. Although TCE is mainly used as a solvent to degrease metal parts, it is also used in several household products including; paint removers, adhesives, and spot removers. TCE is a widely used chemical, and approximately 400,000 workers are routinely exposed to it in the United States. TCE quickly evaporates at room temperatures, and is most commonly released to air from industrial processes. When disposed at chemical waste sites it has the potential to enter soil and groundwater. The compound has only slight solubility in water. It is a dense non-aqueous phase liquid (DNAPL), which has a higher density than water (USEPA, 1992).

Once released to the atmosphere, TCE will persist for several hours to several months, until being

broken down by sunlight. In surface water, the majority of TCE released will evaporate within several hours to several weeks. Any TCE remaining in the water column will settle to the bottom of the water body since it has a greater density than water. TCE is unlikely to bio-concentrate in aquatic life, or adsorb substantially to sediments and soils. In soils, due to its volatility and low adsorption to soil, TCE will evaporate quickly and/or rapidly leach into the groundwater. Adsorption of TCE to soil organic matter of clay matrices may occur, but does not usually lead to retention of high concentrations of the chemical in surface soils. Once in the groundwater, liquid TCE will migrate downward until reaching a less permeable layer. Microbial degradation of TCE in anaerobic groundwater can produce cis- 1,2- DCE, 1,1-DCE and vinyl chloride.

The most common exposure routes for TCE is through inhalation of vapors or direct contact of the solvent with skin. Dizziness, sleepiness, headaches, and skin rashes can occur following acute exposure of individuals to high levels of TCE. There is strong evidence that TCE can cause kidney cancer in people and some evidence for liver cancer and malignant lymphoma. The International Agency for Research on Cancer (IARC) and USEPA have classified TCE as carcinogenic to humans. USEPA designates TCE as a CERCLA hazardous substance with a reportable quantity pursuant to the Clean Water Act, Clean Air Act, and Resource Conservation and Recovery Act. A recent review of developing toxicity and exposure data for TCE by the USEPA in 2016 resulted in a lowering of the recommended health-based screening and action levels for use in CERCLA site assessment investigations (USEPA, 2015a).

2.4.2 Chromium and Hexavalent Chromium

In addition to TCE, Chromium is another contaminant of concern for the Camdenton Sludge Disposal Area. Except as otherwise noted, the information provided herein was taken from the Toxicological Profile for Chromium (ATSDR, 2012a, ATSDR, 2012b).

Chromium is a naturally occurring element found in rocks, animals, plants and soil. The most common forms are trivalent chromium (Cr^{+3}), and hexavalent chromium (Cr^{+6}). Chromium compounds are stable in the reduced Cr^{+3} state (Palmer and Puls, 1994) and occur in nature with this valence charge in ores, such as ferrochromite ($FeCr_2O_4$). Cr^{+3} is an essential micronutrient that helps the body use sugar, protein and fat (Hewlings and Medeiros, 2009). Cr^{+6} is the second most

stable, oxidized state. Hexavalent chromium is rarely found in nature, but may be produced from anthropogenic sources and is more toxic to humans. Cr^{+6} occurs naturally in the relatively rare minerals crocoite ($PbCrO_4$) and Hashemite ($BaCrO_4$) (Puls et al., 1994). Both Cr^{+3} and Cr^{+6} are used for chrome plating, making dyes and pigments, leather tanning and wood preservation.

The solubility of chromium compounds varies, depending primarily on the oxidation state. Trivalent chromium compounds, with the exception of those bound to acetates, hexahydrates of chloride, and nitrate salts, are generally insoluble in water. The zinc and lead salts of chromic acid are practically insoluble in cold water. The alkaline metal salts (e.g., calcium, strontium) of chromic acid are less soluble in water. Some hexavalent compounds, such as Cr^{+6} oxide (chromic acid), and the ammonium and alkali metal salts (e.g., sodium and potassium) of chromic acid are readily soluble in water. The Cr^{+6} compounds in solution are reduced to the trivalent form in the presence of oxidizable organic matter (Puls et al., 1994a). However, in natural waters where there is a low concentration of reducing materials, Cr^{+6} compounds are more stable.

Bioaccumulation of chromium from soil to aboveground parts of plants is unlikely to occur. There is no indication that bio-magnification of chromium occurs along the terrestrial food chain (soil-plant-animal).

Total chromium concentrations in U.S. soils range from 1 to 2,000 mg/kg, with a mean of 37.0 mg/kg. The average chromium concentration in agricultural soils of Camden County in Missouri is 52 mg/kg, which is slightly less than the statewide average of 54 mg/kg in Missouri (Tidball, 1984). Chromium in soil is mostly present as insoluble carbonate and oxides of Cr^{+3}; limiting mobility. The solubility and mobility of Cr^{+3} in soils may increase due to the formation of soluble complexes with organic matter in soil with a lower soil pH, potentially facilitating complexation. The treatment of the soils with liming agents to increase the pH within the Camdenton Sludge Disposal Area likely reduced the probability that chromium will be leached into shallow groundwater on site.

3.0 WASTE/SOURCE SAMPLING

Waste/Source sampling was not conducted during this Site Reassessment investigation. A detailed summary of past waste/source sampling from the 1999 Combined PA/SI investigation for Camdenton Sludge Disposal Area can be found in Sections 2.3.2 and 2.3.2.1.

4.0 GROUNDWATER PATHWAY

4.1 Hydrogeologic Setting

The site lies in the Salem Plateau groundwater province which is located in the northern portion of the Ozark Highlands physiographic province (Miller and Vandike, 1997, Missouri Water Atlas, 1986). The topography of the Salem Plateau is characterized by rolling uplands with rugged hills dissected by entrenched, narrow stream valleys. Karst features, such as springs, sinkholes, and losing streams, are common (Bachle, 2017a, Elfrink 1999).

4.1.1 Soil

Soils in the Camdenton Sludge Disposal Area belong to the Lebanon, Viraton, and Union silt loams series'. Perched water may occur in Viraton soils due to reduced infiltration where an 11" thick fragipan feature reduces infiltration rates (fragipan is a domelike accretion of fine silts at depth - located on site at approximately 20" below the soil surface- that slows infiltration rates [Dingman, 2002, USDA, 1994]). Viraton silt loam soils can be acidic, neutral or slightly alkaline (pH 4.5 to 7.3) with low permeability (0.6 to 2.0 inches per hour at the surface and as low as <0.06 inches per hour at 19-30" depth where fragipans are present [USDA, 1994]). The subsoils on site are comprised of cherty clay residuum. The soil and residuum are approximately 10 ft. deep on site.

4.1.2 Ozark Aquifer

The Ozark Aquifer, which includes all bedrock units above the Cambrian-age Derby-Doerun Dolomite, is the shallowest aquifer beneath site (Table 4). The total thickness of the aquifer is approximately 950 feet. Depth to groundwater within the Ozark aquifer is estimated to be from 235- 290 feet below ground surface (bgs) on site. In some locations perched groundwater may

exist at lesser depths below the surface. The area surrounding the Camdenton Sludge Disposal Area is considered a groundwater recharge zone with characteristic downward flow gradients. Analysis of local groundwater identified two separate pathways with shallow groundwater flowing eastward to surface in Dry Auglaize Creek and deeper groundwater flowing to west to the Niangua Arm of the Lake of the Ozarks. Discrepancies in groundwater flow direction may be due dissolution features creating conduits in the karst environment. While past dye trace studies have shown multiple flow pathways for area groundwater the potentiometric surfaces display an overall declining gradient towards the Lake of the Ozarks and therefore the dominant groundwater flow direction is most likely to the north and west from the site.

The Ordovician aged Roubidoux formation is the first bedrock layer encountered below the quaternary aged soil and residuum on site. Missouri Geological Survey staff estimated that the Roubidoux formation is approximately 50 ft. thick at the Camdenton Sludge Disposal Area site which is typically not thick enough to produce usable quantities of groundwater (Elfrink, 1999). The Roubidoux formation is composed of clayey residuum, sandstone and sandy dolomite with a hydraulic conductivity of $1x10^{-3}$ cm/sec (Table 4).

The Gasconade Dolomite forms another Ordovician aged lithological layer situated directly beneath the Roubidoux formation on site. The upper portions of the Gasconade Dolomite may provide some resistance to contaminants entering the aquifer as it has been described as competent low permeability bedrock (Elfrink, 1999). However, the presence of karst features and penetration of this stratum by poorly cased wells could form preferential pathways for contaminant dispersal. The Gasconade Dolomite is comprised of cherty dolomite, minor factions of sandstone and shales with an overall hydraulic conductivity of $1x10^{-6}$ m/sec.

The Gunter Sandstone formation is located below the Gasconade Dolomite. This layer is approximately 25 feet thick at the site and is the deepest set Ordovician aged formation below the site. The Gunter Sandstone is a pure sandstone feature with relatively high hydraulic conductivity ($1x10^{-4}$ cm/sec) that is known to produce large quantities of groundwater.

Cambrian rocks in the Camdenton area were deposited in a complex depositional environment.

The Camdenton Sludge Disposal Area is located near the western margin of a Cambrian-age intra-shelf sedimentary basin known as the Central Missouri Basin (Palmer and Hayes, 1997). During Cambrian time, the Camdenton area was part of an emerging tectonic feature known as the Lebanon Arch. The north-south trending Lebanon Arch consists of carbonate platform rocks that in some areas, thin over Precambrian highlands (Gregg et. al., 1989).

Because of the tectonic setting, Cambrian beds in the Camdenton area are difficult to categorize, and “layer-cake” stratigraphy should not be assumed. Dramatically different lithologies and abrupt facies changes are depicted in area well logs (Figure 7). Several minor faults are present within four miles of the site (Figure 8).The Cambrian aged deposits of the Eminence dolomite make up the next geologic layer below the Ordovician aged Gunter Sandstone. This layer is comprised of approximately 550 ft. of cherty dolomite which has a conductivity of $1x10^{-5}$ cm/sec.

The Potosi Dolomite lies below the Eminence dolomite and is approximately 50 ft. thick on site. Comprised of Cambrian aged deposits of dolomite with abundant quartz and druze quartz, the Potosi dolomite has relatively high hydraulic conductivity ($1x10^{-4}$ cm/sec) and produces large quantities of water to area wells. The Potosi dolomite is the deepest geologic layer of the Ozark aquifer.

4.1.3 St. Francois Confining Unit

The Cambrian-age Derby- Doerun dolomite and Davis Formation make up the St. Francois Confining Unit beneath the site. The Derby- Doerun dolomite and Davis Formation are made up of slow permeability shaley dolomites and shales. The St. Francois Confining Unit is approximately 160 ft. thick below the site (Table 4). The St. Francois Confining Unit is considered a reliable aquitard capable of arresting further downward migration of contaminants reaching that depth.

4.1.4 St. Francois Aquifer

None of the drinking water wells within 4 miles of the site penetrate the Cambrian-age Bonneterre Formation and Lamotte Sandstone that constitutes the St. Francois aquifer. This 390- 400 foot thick formation consists of dolomite, limestone, sandstone, and arkosic conglomerates. The St.

Francois aquifer has hydraulic conductivities of 1 x 10^{-5} cm/sec in both the Lamotte Sandstone and dolomite and limestones of the Bonneterre portions (Table 4). Groundwater flow direction within the McNairy aquifer is not known for this location.

4.1.5 Basement Confining Unit

The Cambrian aged deposits of the Basement Confining Unit lie below the Lamotte Sandstone formation on site. This formation is comprised of igneous and metamorphic rocks and does not yield water to wells used in this area. Therefore, aquifer characteristics of the Basement Confining Unit are poorly known.

4.2 Groundwater Targets

Groundwater use within four miles of the site is extensive. Sixteen public and 272 private wells provide groundwater to residents within four miles of the site (Bachle, 2017b). Approximately 5,315 individuals rely on groundwater from public and private wells within 4 miles of the site (Table 5). Locations of wells within 4 miles of the site can be viewed in Figure 9 in Appendix A. A description of the well use from the 1999 Camdenton Sludge Disposal Area PA/SI (with relevant updates) follows (Wilder, 1999a).

4.2.1 Public Drinking Water Wells

Public Water Supply District #2 (PWSD2) of Camden County Well #1 is located just east of Highway 5 at the Camdenton Memorial Airport, approximately 0.6 of a mile northwest of the sludge disposal area. The well was drilled in 1974 to a total depth of 848 feet with 330 feet of 6 inch steel casing. The pump is set at 415 feet. PWSD2 personnel reported that Well #1 is used as a reserve well, and is only turned on once a week for a maintenance check. PWSD2 Well #2 is located just east of Highway 5, approximately 3.1 miles south-southwest of the site. PWSD2 Well #2 is the primary well that supplies 99% of the water for the district (Wilder, 1999a). Camden County PWSD2 served 800 people in 1989 and has grown to serve 1,400 residents in 2018 (McCormick, 1989, MDNR, 2017a, MDNR, 2018).

The City of Camdenton's Rodeo well is located on Rodeo Road in the City of Camdenton,

approximately 3.6 miles northwest of the site. The Rodeo well was drilled in 1961 to a total depth of 940 feet with 450 feet of eight-inch steel casing. The pump is set at 420 feet (MDNR, 2017b). The Rodeo well served an apportioned 993 people in 1999 and would serve close to 1,000 apportioned customers if it were running but it is currently on standby and is only pumped in emergencies (McCormick, 1989, MDNR, 2017a).

The other public drinking water wells within the four mile radius are actually privately owned ‘community’ drinking water wells which have fifteen or more service connections and provide drinking water to twenty five or more people and therefore designated as ‘public wells’ by the departments public drinking water branch (MDNR, 2017a). These ‘community wells’ may serve mobile home parks businesses or institutions.

4.2.2 Private Drinking Water Wells

Within four miles of the site, there are 288 wells recorded in the Missouri Geological Survey (MGS) databases. The MGS Well Wellhead Protection Section’s Water Well Information System (W.I.M.S.) database contains information on wells drilled since 1987 (Bachle, 2017b). Some wells may no longer be active, and many active wells may not be recorded in DGLS databases. Table 5 presents the breakdown of wells within four miles of the site (Bachle 2017b). The closest private well is located approximately an eighth of a mile west of the site and was sampled in the 1999 PA/SI as well as in the Site Reassessment.

4.3 Groundwater Sampling

4.3.1 SR Groundwater Sampling Methods

Drinking water well samples were collected from the closest available point near the well head. Taps were opened at a high flow for five minutes. Specific conductivity, pH, and temperature were monitored during purging. Following the initial five minutes of purging the wells were allowed to continue to run for an additional three minutes and field measurements were collected again. If all parameters were stabilized, (pH within 0.2 units, temperature and specific conductivity within +/- 10%) a sample was collected. If water quality parameters were not within stable range then the tap was allowed to continue to flow for an additional three minutes and this sequence was repeated

until parameters stabilized. Groundwater samples collected for dissolved metals analysis were filtered in the field prior to submission to the laboratory. Samples collected for VOC analysis were preserved with hydrochloric acid (HCl) and the samples gathered for metals analysis were preserved with nitric acid (HNO_3). The samples were labeled, recorded on chain of custody forms and stored on ice until submission to the laboratory for analysis.

Locational data was collected at each wellhead using a Trimble GeoExplorer handheld global positioning system (GPS) with a minimum logging time of 60 seconds, and corrected using post-processing.

All groundwater samples were analyzed for VOCs and select metals (barium, chromium, copper, lead and zinc). Due to concerns that hexavalent chromium may be present, it was determined that drinking water samples would be analyzed for hexavalent chromium in the event that total chromium exceeded 3.5 µg/L (representing the EPA Screening Level for hexavalent chromium at the $1x10\text{-}^{4}$ risk level). This level was chosen to avoid screening out samples that could contain harmful quantities of hexavalent chromium even though the total chromium may be under the 100 µg/L EPA Maximum Contaminant Level (MCL). One sample exceeded the 3.5 µg/L threshold from the Sampling and Analysis Plan (SAP) and was submitted for hexavalent chromium analysis by a contract laboratory along with two background samples for comparison.

4.3.2 Background Wells Sampling Locations

Department staff identified two private wells (Locations 118 and 123) that were estimated to be beyond the influence of the Camdenton Sludge Disposal Area site (at a distance greater than 4 miles [Figure 11]). Samples were collected from these wells on October 2, 2017 and analyzed for VOCs. Both wells were resampled on October 19, 2017 and analyzed for metals in order to establish background groundwater conditions in the Ozark Aquifer. Follow-up sampling for lead was conducted at Location 123 on February 13, 2018 (further discussed in Section 4.4.2).

4.3.3 Private Wells Sampling Locations

The department's ESP and Hazardous Waste Program (HWP) staff sampled 11 private drinking water wells generally located within one half mile of the site on October 2, 2017, and analyzed for

VOCs and select metals (Figure 10, Appendix A). The private wells at Locations 109, 110 and 111 had been previously sampled for the 1999 PA/SI (referred to then as “Private Well”, 3496 RR3 Private Well and 3499 RR3 respectively) and the results are discussed in Section 2.3.2 of this report.

The same 11 private wells were resampled and analyzed for metals on October 19, 2017, as part of a follow up effort to confirm initial findings and to clear up an anomaly in the original sample results (discussed in Section 4.4.1).

4.3.4 Public Well (Location 106) Sampling Location

The department’s ESP and HWP collected a sample from the Camden County Public Drinking Water Supply District # 2 (PWSD2) backup Well #1 on October 2, 2017, for analysis of VOCs and select metals. The PWSD #2 Well #1 is located alongside the entrance to the KOZS airport entryway at a distance of just over one half mile from the Camdenton Sludge Disposal Area site (which is located at the other end of the airport property [Figure 10]). The same well was sampled during the 1999 PA/SI investigation of the Camdenton Sludge Disposal Area and was analyzed for VOCs and metals (discussed above in Section 2.3.2). The well was resampled on October 19, 2017, and submitted for analysis of total and dissolved chromium, hexavalent chromium, and zinc.

4.4 Groundwater Sample Results

4.4.1 Background Wells

Sampling documentation and analytical results are provided in Appendix D. Results are summarized in Tables 6 and 7 of Appendix B. No VOCs were detected in the two background wells. The sample from Location 123 contained 23.7 µg/L lead, which exceeds the USEPA National Primary Drinking Water Regulations Action level for lead of 15µg/L. Follow-up sampling was conducted at this location on February 13, 2018 to confirm the initial findings. Samples were collected from the wellhead, the kitchen tap, the refrigerator tap (charcoal filtered) and from a countertop Britta (charcoal) filter pitcher.

Additional sampling conducted at Location 123 revealed that the water in the indoor faucet also contained lead at concentrations above the Action Level. However, the filtration systems that the homeowner was using had either reduced the lead (pitcher filter) or had completely eliminated the lead (refrigerator filter). The wellhead sample contained 28.5 µg/L lead; 27.9 µg/L lead was detected at the kitchen faucet; 10.7 µg/L in the filter pitcher; and <0.5µg/L at the refrigerator. The homeowner at Location 123 was informed of the lead content of their well water and advised by department staff to filter their drinking water before consuming it. The contaminated well was referred to the USEPA Region 7 Removal Program for potential action as a part of the Central Mining District Lead - Camden County (EPA ID No MON000705679.) response.

Due to elevated lead detected in the well water at Location 123, thought to be related to lead mining in the area, it was determined that the well may not be representative of general water quality conditions in the Ozark Aquifer. Therefore, only water quality data from well location 118 were used to represent background groundwater conditions for the site (Table 7). The background sample from location 118 did not detect any total chromium and had 0.013 µg/L of hexavalent chromium which is below all of the relevant screening levels. Lead was not detected in the Location 118 sample. Although barium, copper and zinc were measured at low levels in the groundwater sample from Location 118, no metals were detected at levels above the National Primary or Secondary Drinking Water Standards (Table 7).

4.4.2 Private Wells

Sampling documentation and analytical results are provided in Appendix D. Results are summarized in Tables 6 and 7 of Appendix B. No VOCs (including TCE) were detected in any of the private drinking water well samples. Chromium was not detected in any of the private wells using EPA method 200.7 for analysis (a matrix interference was identified with EPA method 200.8 and the results were flagged with a "(k)"- matrix interference is described below in section 4.4.3). Barium was detected in all samples, but not at concentrations significantly above background (greater than 3x), nor above the MCL. Copper and zinc were detected in some wells at concentrations significantly above background, but below their respective Secondary MCLs. Copper was detected above background levels in groundwater samples from private wells at

Locations 101, 103, and 111, but all the detections were all at least one order of magnitude below the Secondary MCL of 1,300 µg/L (USEPA, 2015b, USEPA, 2017). Zinc was detected at concentrations above background levels in groundwater samples from all private wells except Locations 105 and 108, however, these concentrations were an order of magnitude below the Secondary MCL of 5,000 µg/L. Lead was detected above background levels in groundwater samples from well Locations 101, 111, and “background” Location 123 (see discussion of Location 123 well results in Section 4.4.1). Lead levels only exceeded the 15 µg/L National Primary Drinking Water Standards Action Level at Location 111 (63.6 µg/L).

The well at Location 111 was resampled on October 19, 2017 to confirm the lead detection. The home has a water softener that serves the kitchen and bathroom taps. Samples were collected from near the wellhead (pre-softener) and from the kitchen tap. The wellhead sample contained 28.8 µg/L lead, confirming the previous finding. Analysis of the kitchen faucet sample was non-detect for lead, indicating that the water softener was reducing the lead concentration.

4.4.3 Public Well (Location 106)

Sampling documentation and analytical results are provided in Appendix D. Results are summarized in Tables 6 and 7 of Appendix B. No TCE or other VOCs were detected in the public well. Chromium, lead and zinc were detected at concentrations above the background well (Location 118) levels, but all results were far below the USEPA’s National Primary or Secondary Drinking Water Standards.

Total chromium was detected during both the October 2, 2017 (3.25 µg/L) and October 19, 2017 (4.41 µg/L) sampling events (dissolved chromium was non-detect – see Section 4.4.1). Although these concentrations are well below the National Primary Drinking Water Standard MCL for total chromium of 100µg/L, the October 2nd sample result exceeded the criteria of 3.5 µg/L established in the SAP for triggering analysis of the sample for hexavalent chromium (Brown, 2017). Therefore, the samples collected on October 19, 2017 from both the public well and the background wells were submitted for analysis of hexavalent chromium. Hexavalent chromium was detected in the public well at 0.31 µg/L which exceeds the background concentration at well

Location 118. Hexavalent chromium is not addressed under the National Primary or Secondary Drinking Water Regulations, nor are there benchmarks available in the USEPA Superfund Chemical Data Matrix table (USEPA, 2018a). However, the 0.31 µg/L hexavalent chromium detected in the public well is below the 3.5 µg/L (10^{-4} risk level) USEPA Removal Management Levels for hexavalent chromium of (USEPA, 2018c). However, new toxicity information for hexavalent chromium is currently being evaluated at both the state and federal level, and these benchmarks are under review (Hartman, 2018).

4.4.2 Quality Control

A trip blank was processed and analyzed for VOCs along with the groundwater samples collected on site during the sampling event conducted on October 2, 2017. No VOCs were detected in the trip blank.

Duplicate groundwater samples were collected on October 2, 2017, from the private well at Location 109. Table 8 provides a comparison of results for the duplicate samples. Precision, measured as the relative percent difference between results for analytes detected in both samples ranged from 0.0 % (no difference) for dissolved barium and zinc, to 5.5% in total copper. This level of precision is within the criteria of 30% RPD specified in the SAP (Brown, 2017). When multiple samples were identified with greater dissolved chromium results than total chromium results, the samples were re-run using an alternate USEPA approved method not subject to the matrix interference (described in greater detail below in 4.4.3).

4.4.3 Laboratory Matrix Interference

In addition to VOCs, all water samples were analyzed for both total and dissolved metals. Samples collected for total metals analysis are subjected to an acid digestion process in the laboratory in order to render all metals in the sample available for measurement, including any associated with suspended particulates. Samples collected for dissolved metals analysis are first field-filtered to remove particulates prior to submitting to the laboratory. These samples are not subjected to the acid digestion process in the laboratory since all the particulates have been removed and any metals

remaining in the sample should already be in dissolved form. Therefore, the dissolved metal content of any sample is a subcomponent of the total metal content, and should always be equal to or lower in concentration that the corresponding total metal result.

The October 2, 2017, samples were analyzed by EPA Method 200.8. Non-detect results were reported for total chromium in all samples except at Location ID 106 (Table 6). However, dissolved chromium was detected in every sample. Due to this anomaly, the department resampled all of the wells on October 19, 2017 and submitted them again for analysis of total and dissolved metals by EPA Method 200.8. Results for the resampled wells were identical as before with dissolved chromium concentrations greater than the total chromium, again except for Location ID 106.

The department's laboratory investigated this anomaly and determined there was a false positive matrix interference encountered during analysis of the dissolved metals samples (Thoenen, 2017). The acid digestion process conducted on the samples for total metals analysis (but not on samples for dissolved metals) was found to have removed this matrix interference.

In order to confirm that this was the cause of the false positive interference, remaining sample from all of the wells collected during both of the October sampling events were analyzed using EPA Method 200.7, an alternative method which is not susceptible to the matrix interference problem encoutered with EPA Method 200.8. Results of the reanalysis revealed no detectable dissolved chromium in any of the samples, confirming there had been a false positive interference on the dissolved metals samples analysed using EPA Method 200.8.

Based on these findings, the data indicate that no dissolved chromium is present in any of the well samples collected and that total chromium is only present at low concentration in one of the wells (discussed above in Section 4.4.3).

4.5 Groundwater Conclusions

Results from private and public wells in the vicinity of the site collected in 1999 and 2017 by the

department do not document a release of VOCs at the Camdenton Sludge Disposal Area site.

The groundwater sample results from the SR are also largely consistent with the results of the 1999 SI groundwater sampling. Some of the same wells were sampled during both investigations and the groundwater results are similar. The only outliers are the privately collected groundwater samples in the 1999 PA/SI that were not subject to quality assurance protocols during sampling and were analyzed by private laboratotories. While the initial privately collected and analyzed well samples from 1999 detected TCE, samples collected by department personnnel and analyzed at Department laboratory were unable to replicte these results. Likewise, no VOCS were detected in any of the samples collected and analyzed by MDNR personnel in either the 1999 SI or the 2017 SR sampling.

Several metals have been detected in groundwater samples collected in October 2017, at levels greater than three times the concentrations found in one background well. Chromium, copper, and lead were found at levels significantly greater than background concentrations. However, only lead at one well was found in one well above the MCL. Chromium and copper and did not exceed Primary or Secondary MCLs in any wells.

Lead was not one of the contaminants found at high concentrations in the sludge itself. The lead found in these wells is likely caused by aging pipes and equipment or from historical lead mining activities in the area. While lead was detected in soils at greater than three times background levels in the 1999 Camdenton Sludge Disposal Area PA/SI investigation, it was not above the USEPA Residential Removal Management Level of 400 mg/kg (USEPA, 2018c). The highest lead concentration detected in the 1999 soil sampling on site was 121 mg/kg, which is highly unlikely to result in groundwater contamination observed in the nearby well.

While 4.41 µg/L of total chromium was detected in the public well at Location 106 it is below the National Primary Drinking Water Standards level of 100 µg/L chromium. The state of Missouri standards for hexavalent chromium for drinking water remain under review by the Missouri Department of Health and Senior Services at this time. The 0.31 µg/L of hexavalent chromium detected in the County well at Location 106 is below the 3.5 µg/L Removal Management Level

(USEPA, 2018c) at which remedial action would occur. Given that the Camden County PWSD#2 Well #1 is only utilized on an emergency basis the hexavalent chromium levels are unlikely to pose a risk to consumers, who are regularly served by another well located over three miles from the site. In the event that the PWSD#2 Well #1 is selected for regular use it would be subject to sampling by the department's Public Drinking Water Watch to ensure water quality.

Migration of metals from the sludge to groundwater would have been limited by the application of lime to adjust soil pH after the sludge was land-applied in 1999. Any metals that are leached into the subsurface would be further slowed upon contacting the calcareous limestone bedrock with cations such as chromium (+3) precipitating out of the water column in areas with high pH groundwater (Puls et al., 1994). The expansion of the airport runway (Mrockza, 2016, Coleman, 2017) covered a portion of the sludge disposal area, which would further limit infiltration and potential leaching of metals from residual sludge material.

No further assessment of chromium or other metals is needed at this time.

5.0 SURFACE WATER PATHWAY

5.1 Hydrologic Setting

The Camdenton Sludge Disposal Area is situated near the crest of broad ridgetop that acts as the drainage divide between streams draining northwest, toward the Niangua Arm of the Lake of the Ozarks and streams draining east, toward the Dry Auglaize Creek. South and east of the site, unnamed streams flow southeast toward Forbes Branch. The natural landforms and drainage patterns at the site have been partially obscured by airport construction and soil disposal. The site itself has been leveled; while the surrounding terrain exhibits low natural relief (2% to 4% slopes). Land use patterns for the surrounding upland near the site include residential and agricultural properties with some light-industrial use. The steeper slopes are generally forested (Elfrink, 1999).

Surface runoff from the sludge disposal area flows eastward for several hundred feet to an unnamed intermittent stream, which then flows for one mile before entering the intermittent Forbes

Branch, and flows another 1.2 miles before entering the perennially-flowing Dry Auglaize Creek. Both Forbes Branch and Dry Auglaize Creek are losing streams. Because the overland flow distance to the nearest perennial surface water is more than two miles, the surface water pathway is not evaluated for this site (Elfrink, 1999, Bachle, 2017a).

5.2 Surface Water Conclusions

The surface water pathway was not evaluated due to an overland flow distance to a perennial stream greater than two miles.

6.0 SOIL EXPOSURE AND AIR PATHWAYS

6.1 Soil Physical Conditions

The native soils in the vicinity of the Camdenton Sludge Disposal Area are Lebanon and Variton silt loams (Figure 12). Both Lebanon and Variton silt loam soils are deep, moderately well-drained soils typical of ridgetops. Permeability is moderate, although a shallow fragipan, if present, may perch water (Dingman, 2002). Surface soils on site may have been disturbed during airport construction and sludge disposal activities and typical structural features may no longer exist.

The 40 acre sludge disposal site is an open field with grassy vegetation. There is no visible sludge on the surface. The sludge was reportedly spread, mixed, and disked into the native soil (except for several piles in the ditch) and the area was then seeded. Visible sludge was only encountered in two of nine soil borings at depths ranging from 0.5’ to 1.0’ depth in the disposal area during the 1999 PA/SI sampling event. It was green in color and easily distinguishable from the surrounding soil. The airport property is fenced preventing individuals from accessing the former sludge disposal area. A portion of the sludge disposal area has been covered by asphalt during runway extension activities and is no longer exposed at the surface. The remainder of the former sludge disposal area is covered by grasses and exposure to surface soils is unlikely to occur.

6.2 Soil and Air Targets

Residential areas are located immediately west, east, and south of the site. Two homes are located on County Road 5-120 within 0.25 of a mile of the site. The residence with the corresponding groundwater sample of 3499 RR3 (in the 1999 PA/SI report) is within 400 feet of the western edge of the site (Wilder, 1999a).

A portion of the City of Camdenton lies within four miles of the site (Bachle, 2017a). Camdenton had an estimated population of 2,544 people in 1990 and has grown to approximately 3,700 in 2019 (USDC, 1991, USDC, 2017). Table 9 in Appendix B, presents a breakdown of the number of people estimated to be within a four-mile radius of the site.

6.3 1999 PA/SI Soil Sampling

Soil sampling in the sludge disposal area was conducted as part of Waste Source sampling on January 22, 1999, as a part of the PA/SI investigation and is summarized above in Section 2.3 of this report (Previous Investigations). No soil samples were collected from nearby residential properties during the PA/SI or this SR as they were located over 400 feet from the sludge disposal area and sludge was not suspected to have migrated from that area over time.

6.4 Soil and Air Conclusions

Over 2,000 cubic yards of sludge from the City Lagoon #3 (Hulett Lagoon) was deposited in a 20-40 acre tract at the Camdenton Sludge Disposal Area site in 1989. The majority of 1999 PA/SI sampling focused on the region near the main ditch in the disposal area. Reportedly, several loads of sludge were deposited into this ditch near the end of the project without any mixing, disking, or spreading. Recognizable sludge material was encountered in two soil borings from the ditch. Levels of chromium, copper, lead, and nickel were documented significantly above background in these two samples. However, chromium was the only compound detected at a level exceeding the SCDM benchmarks. TCE was not detected in any of the eight soil samples collected from the

disposal area in 1999.

Residual sludge material was visible in two of the PA/SI soil samples collected in 1999 near the surface (0.5'-1' depth), but the field is well vegetated and is not currently used for any purpose. The risk of exposure to trespassers or passers-by is likely to be minimal. Airport runway expansion has covered a portion of the original sludge disposal area further reducing exposure risk on site. Residential areas are located immediately west, east, and south of the site. Two homes are located on Forbes road within 0.25 of a mile of the site. Access to the site is restricted by fencing and not open to the public. There is no current exposure to residual sludge material disposed of at the airport.

The air exposure pathway was not analyzed during this investigation.

7.0 SUMMARY AND CONCLUSIONS

The Site Reassessment investigation was initiated on June 30, 2017 in response to citizen concerns that area groundwater may have been impacted by the sludge disposal area, and to investigate allegations that additional locations besides airport had been used as sludge disposal sites. Groundwater samples were collected from 11 private wells and one public well within a half mile of the site. No TCE or other VOCs were detected in the groundwater samples collected by the department in 2017.

The Camdenton Sludge Disposal Area site consists of 40 acres of open field where sludge from the closure of the TCE contaminated City Lagoon #3 (formerly known as Hulett Lagoon) was disposed of in 1989. City Lagoon #3 had received wastes from a manufacturing facility at 221 Sunset Drive which released wastes containing TCE and metals such as copper and chromium. The disposal of sludge wastes from City Lagoon #3 was approved by the department following testing for metals content. The sludge was not tested for TCE at the time. City Lagoon #3 sludge was land-applied at a field on the south side of the Camdenton Regional Airport property. The sludge was mixed with native soil and liming agents were applied to limit metal mobility.

Concerns regarding potential TCE contamination in area wells prompted the department to conduct a Combined Preliminary Assessment/Site Inspection investigation in 1999. The department's sampling of sludge material, surrounding soil and groundwater did not detect TCE during the 1999 investigation. Isolated pockets of sludge materials were encountered and sampled in the 1999 investigation. The only metal detected above background and cleanup levels was chromium in two samples that were identified as sludge. Groundwater samples collected by the department in 1999 from three private wells and one public well near the site did not document levels of chromium or other metals above Primary or Secondary Drinking Water Standards.

Site Reassessment groundwater sampling included sampling 11 private and one public drinking water well in October 2017. No VOCs, including TCE, were detected in any of the wells. Chromium was detected in the (backup) Camden County PWSD #2 Well #1 at concentrations below the National Primary Drinking Water Standard MCL. Hexavalent chromium was detected at 0.31 µg/L, which is below the USEPA Removal Management Level of 3.5 µg/L.

Two of the wells sampled during the Site Reassessment had elevated lead concentrations which are not attributable to the site and likely due to residual contamination from lead mining in the area or deteriorating pipes. One of the wells with elevated lead concentration is several miles from the site and was originally designated as a background well. The Department referred this well to the USEPA Region 7 Removal Program to address the lead contamination under the Central Mining District Lead - Camden County site. The other well had a treatment system that removed lead before consumption.

While the sludge wastes applied on site in 1989 contained hazardous substances, sampling of sludge material and surrounding soil in 1999 did not document a release of hazardous substances at levels above cleanup standards. No TCE or other VOCs were detected in waste source sampling in the sludge disposal area. Results from private and public well sampling conducted in the vicinity of the Camdenton Airport in 1999 and 2017 do not document a release of hazardous substances, including TCE, from the Camdenton Sludge Disposal Area site to the groundwater. All metals (aside from lead not related to the site) detected in groundwater samples were under levels allowable under the National Primary or Secondary Drinking Water Regulations.

No further assessment or action at the Camdenton Sludge Disposal Area site under CERCLA is warranted at this time.

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Approved by: Valerie Wilder

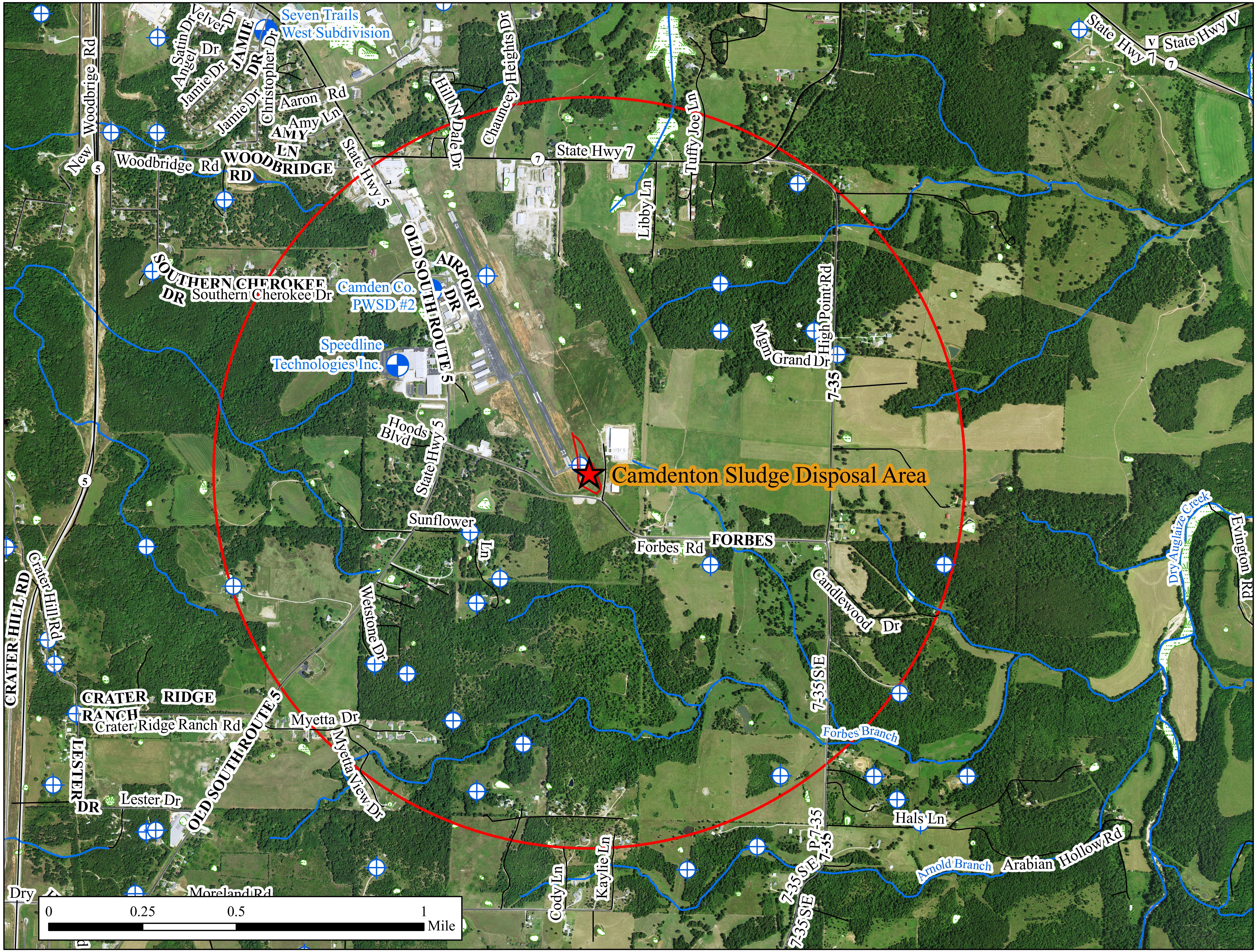
Valerie Wilder, Chief, Superfund Section

Date: 3-11-19

APPENDIX A

FIGURES

Figure 1: Site Location Map
Camdenton Sludge Disposal Area Site
Camdenton Memorial Airport
Camden County, Missouri
February 22, 2019



Legend

- Center of Operations
- Private Drinking Water Wells
- Public Wells
- National Wetland Inventory
- Sludge Field Outline
- Local Roads
- State Lettered Highway
- State Numbered Highway
- Rivers and Streams
- US Census Bureau Roads
- 1 Mile Radius

N W E S

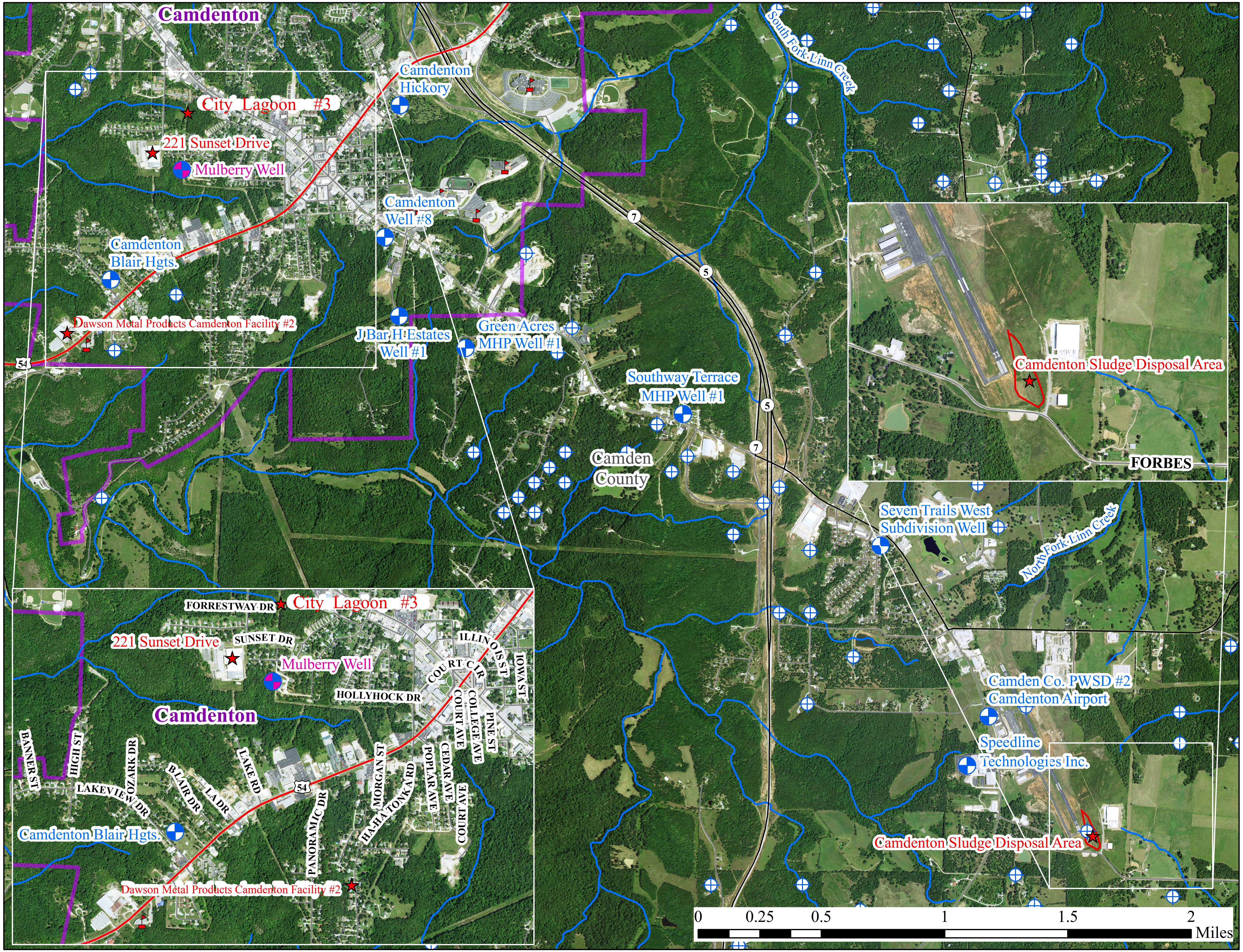
Created on: 5-24-17 by Keith Brown. This map is located at M/Superfund/Camdenton Sludge Disposal Site

Base Map: National Agriculture Imagery Program (NAIP) ortho photography. Flight Date: 2014
Data Sources: US Census 2010;
Missouri Department of Transportation

Although data sets used to create this map have been compiled by the Missouri Department of Natural Resources, no warranty, expressed or implied, is made by the department as to the accuracy of the data and related materials. The act of distribution shall not constitute any such warranty, and no responsibility is assumed by the department in the use of these data or related materials.

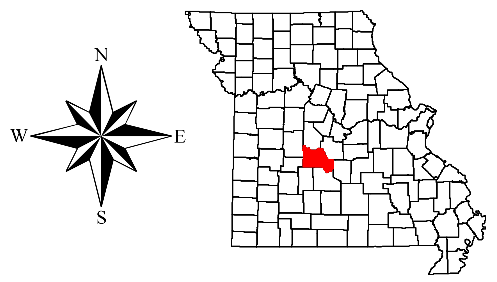
MISSOURI DEPARTMENT OF NATURAL RESOURCES

Figure 2:
Camdenton TCE Areas of Concern Camden County, Missouri



Legend

- Camdenton Sites of Concern
- Public Wells
- Mulberry Well (Inactive)
- Private Drinking Water Wells
- Public Schools
- Sludge Field
- Camdenton City Boundary
- Local Roads
- Federal Highway
- State Lettered Highway
- State Numbered Highway
- Rivers and Streams



Created on: 6-23-17 by Keith Brown. This map is located at M/Superfund/Camdenton Sludge Disposal Site

Base Map: National Agriculture Imagery Program (NAIP) ortho photography. Flight Date: 2014
Data Sources: US Census 2010;
Missouri Department of Transportation

MISSOURI DEPARTMENT OF NATURAL RESOURCES

Figure 3: Sludge Disposal Area Diagram from 1999 PA/SI

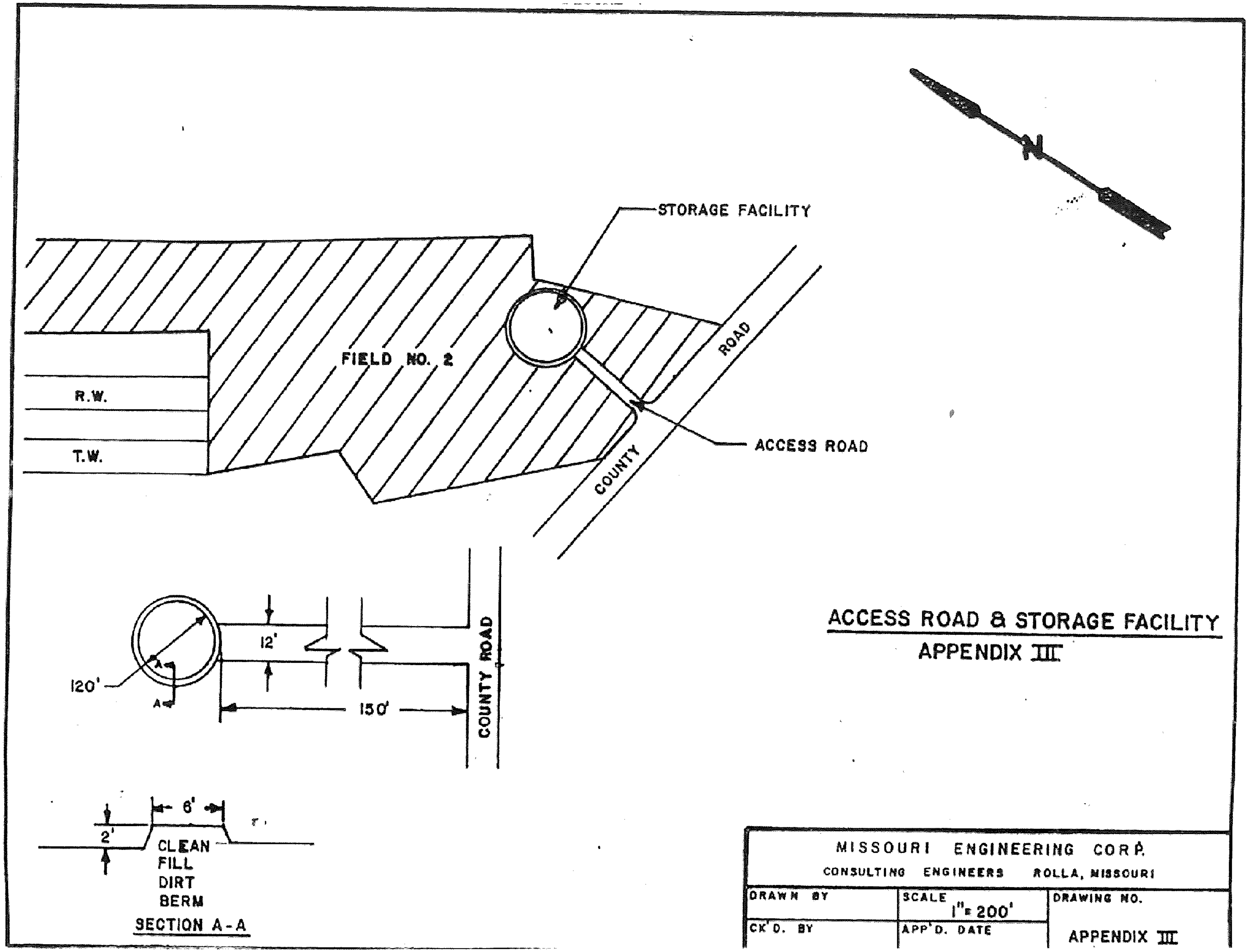


Figure 4: 1999 PA/SI Well Sample Location Map

Figure 3: Camdenton Sludge Disposal Area Well Sampling Locations

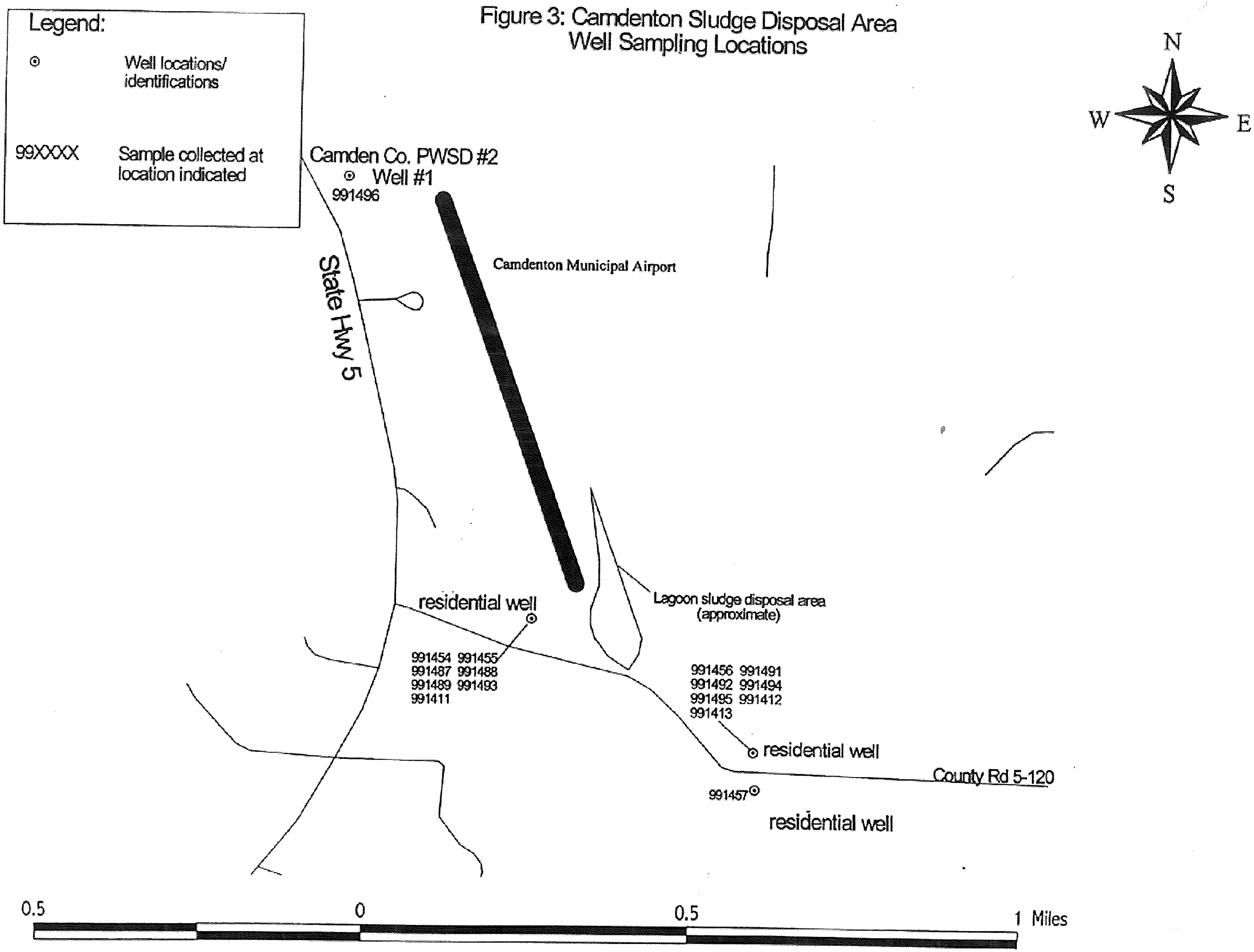


Figure 5. 1999 Camdenton Sludge Disposal Area PA SI Soil Sample Location Map

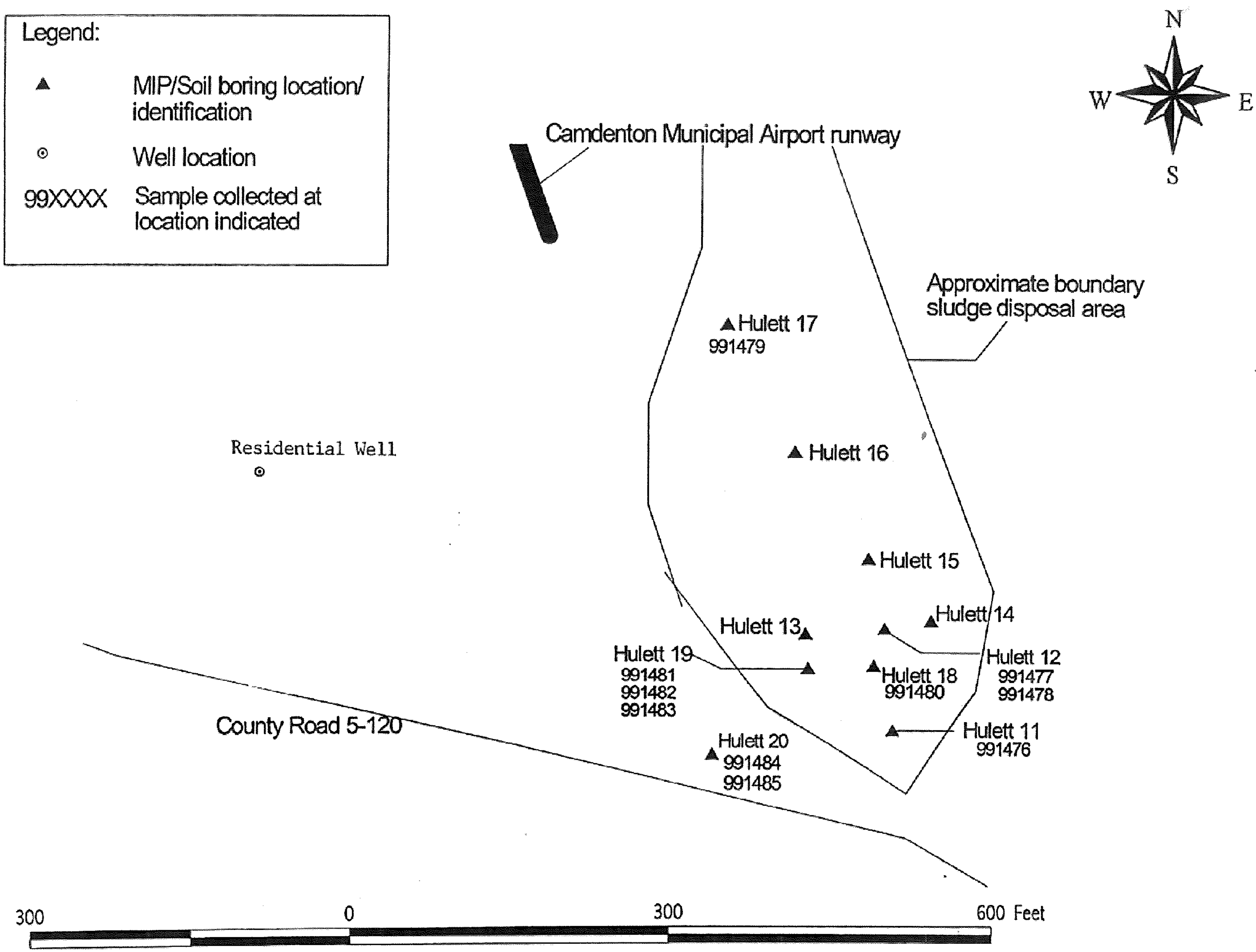


Figure 6 : Sludge Disposal Area Diagram close up from 199 PA/ SI

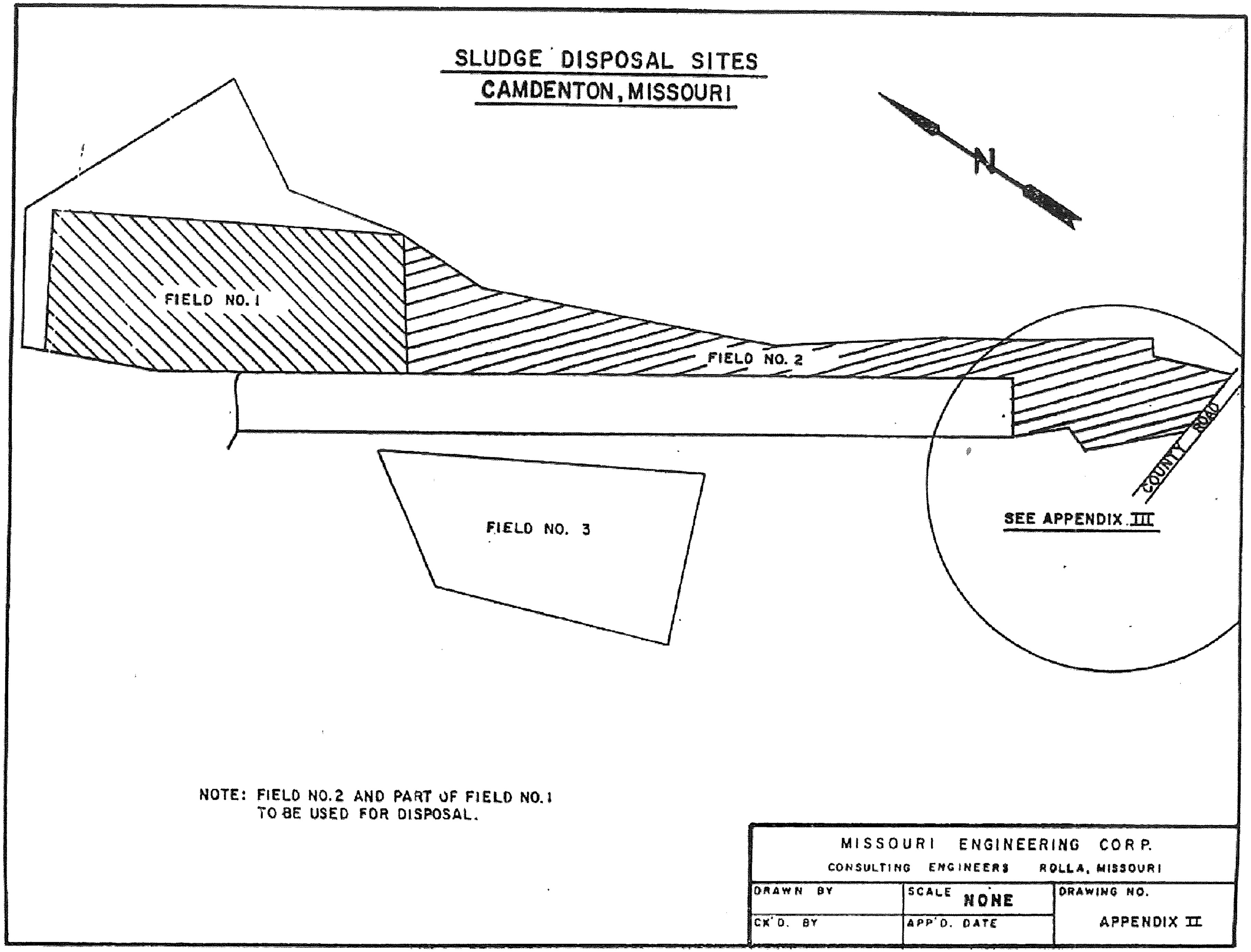


Figure 7: Missouri Geological Survey Well Log Graphic from 1999 PA/SI

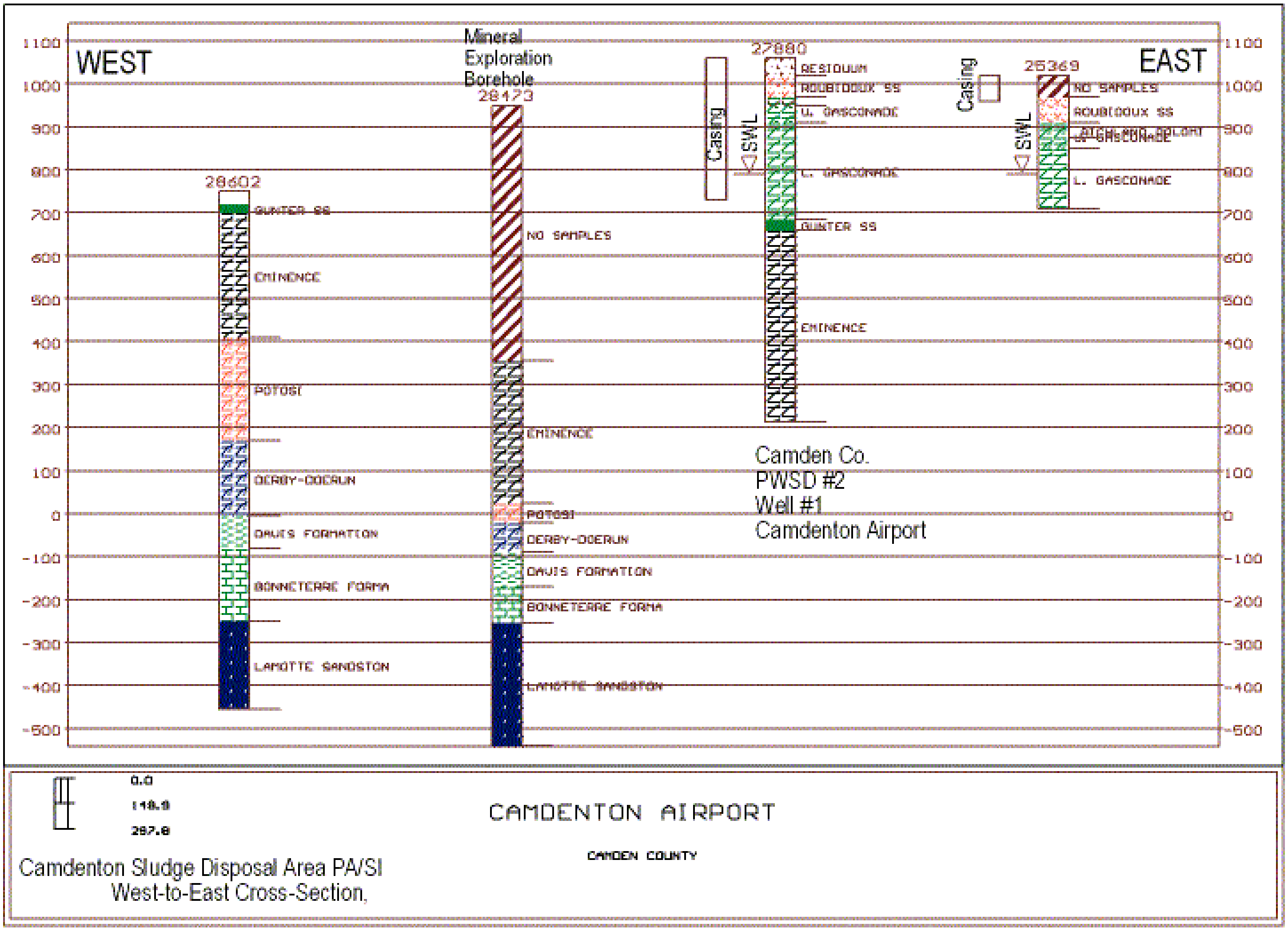


Figure 8 : Missouri Geological Survey Structures of Camden County Map from 1999 PA/SI

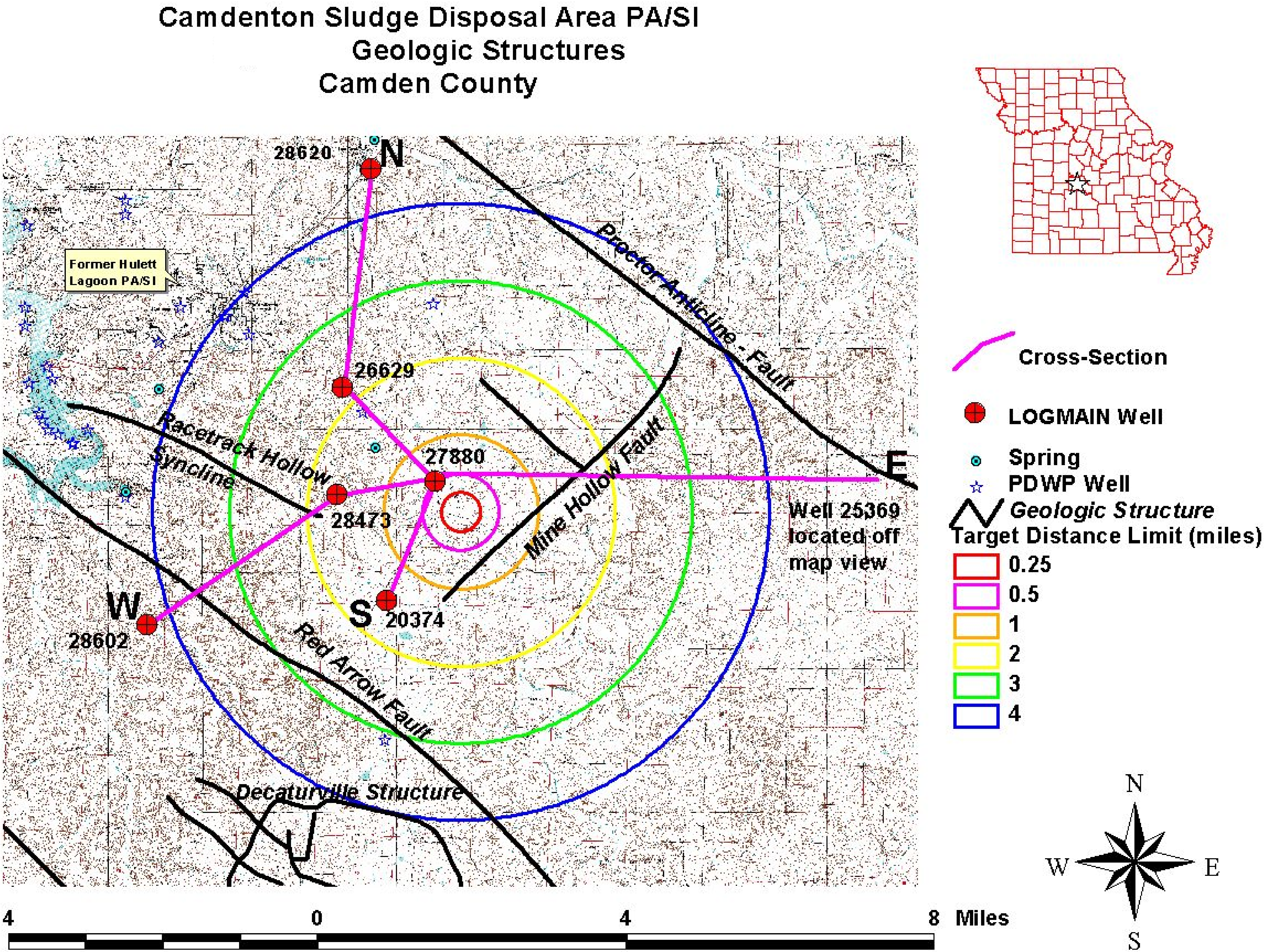


Figure 9 : Wells Registered with the Missouri Geological Survey Within Four Miles of the Site

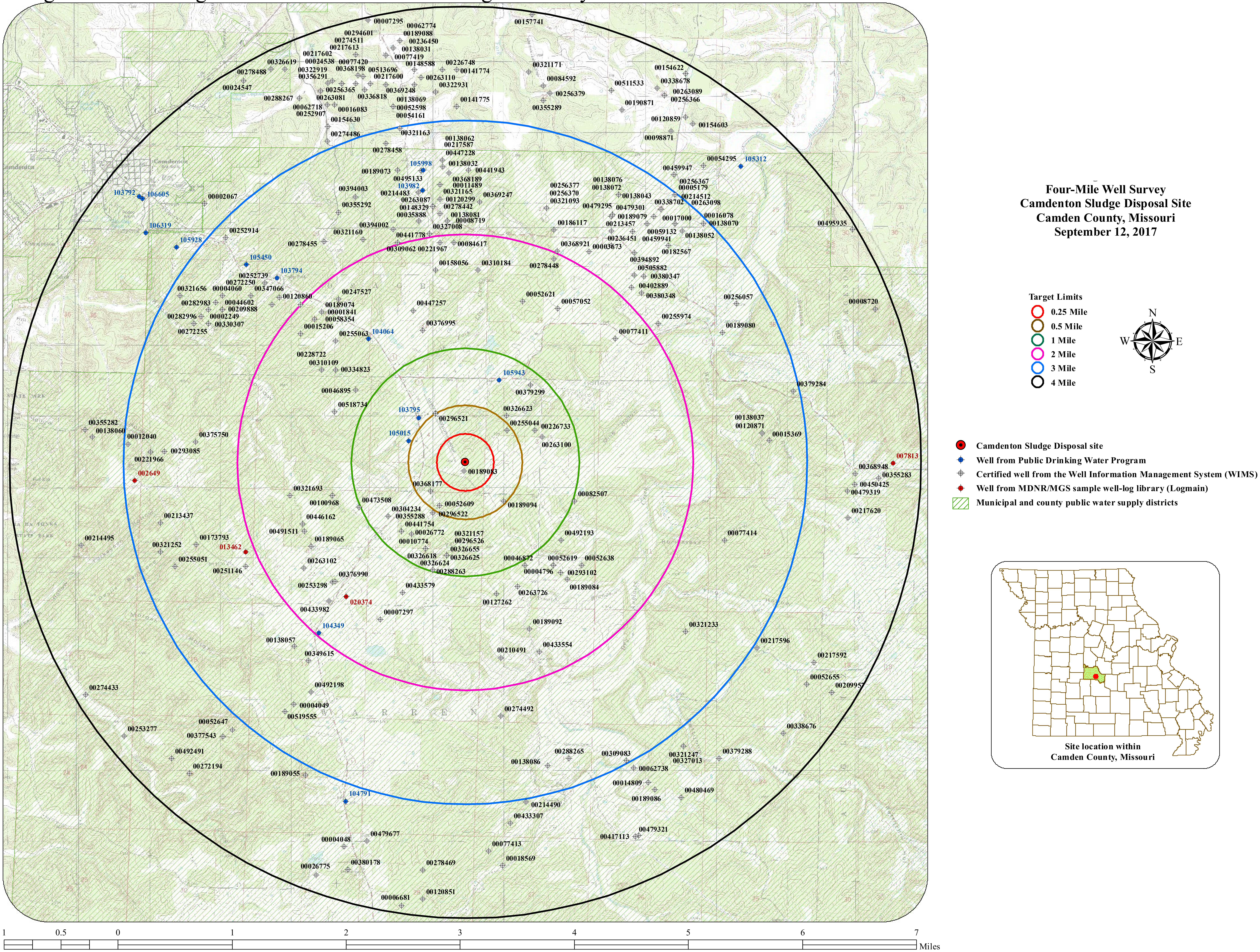
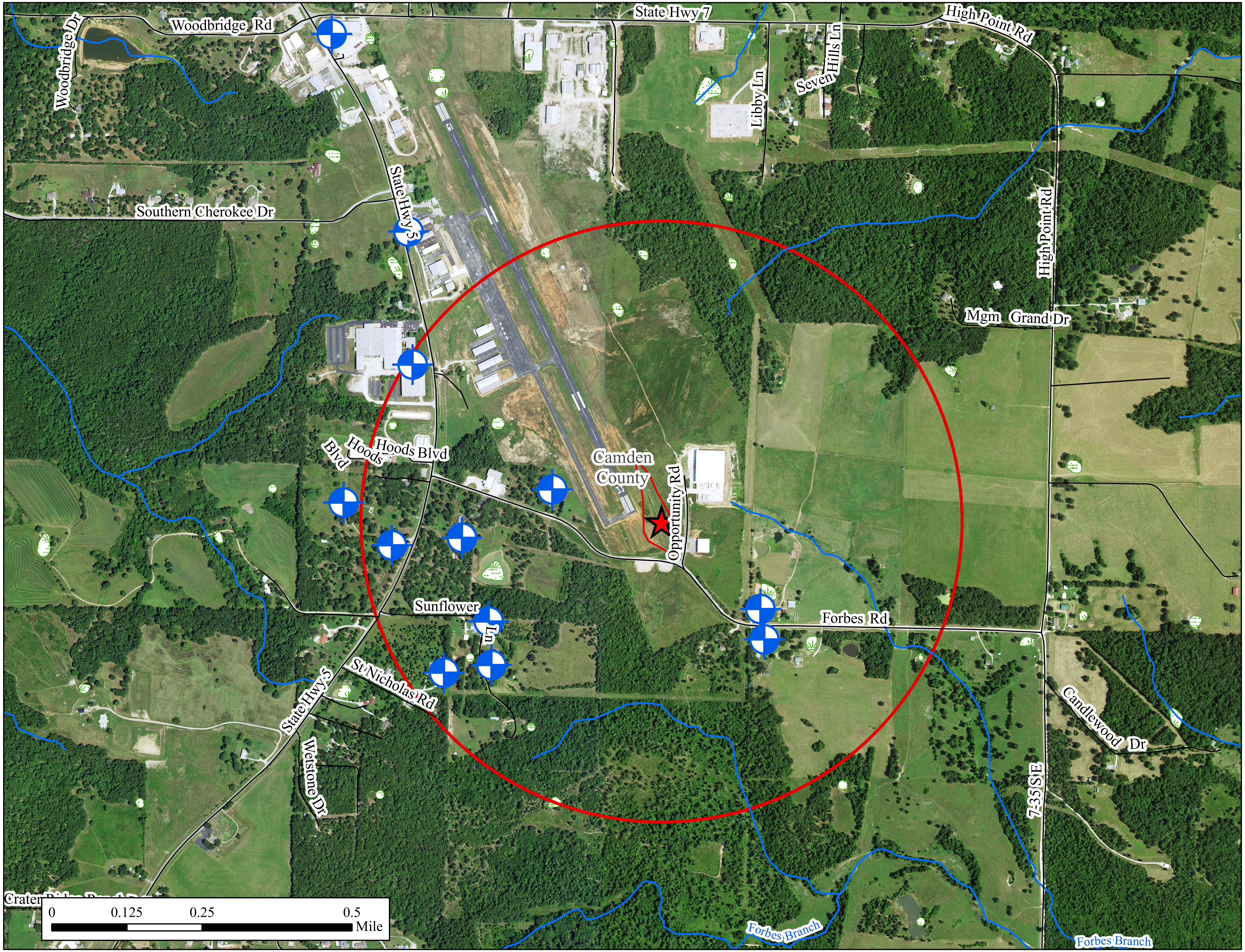
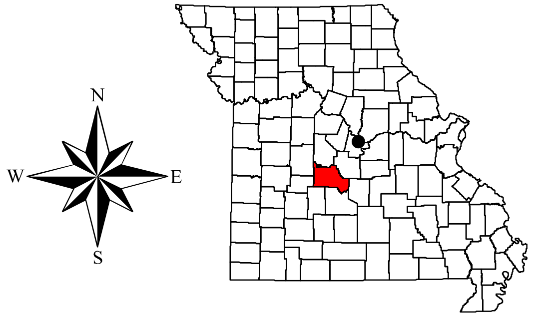


Figure 10:
Site Reassessment Groundwater Sampling Location Map
October, 2017
Camdenton Sludge Disposal Area Site
Camden County, Missouri



Legend

- Sludge Disposal Area Site
- Sampled Well
- Half Mile Radius
- National Wetland Inventory
- Sludge Field Outline
- US Census Bureau Roads
- Rivers and Streams



Created on: 1-05-18 by Keith Brown. This map is located at M/Superfund/Camdenton Sludge Disposal Site

Base Map: National Agriculture Imagery Program (NAIP) ortho photography. Flight Date: 2014
Data Sources: US Census 2010;
Missouri Department of Transportation

Although data sets used to create this map have been compiled by the Missouri Department of Natural Resources, no warranty, expressed or implied, is made by the department as to the accuracy of the data and related materials. The act of distribution shall not constitute any such warranty, and no responsibility is assumed by the department in the use of these data or related materials.

MISSOURI DEPARTMENT OF NATURAL RESOURCES

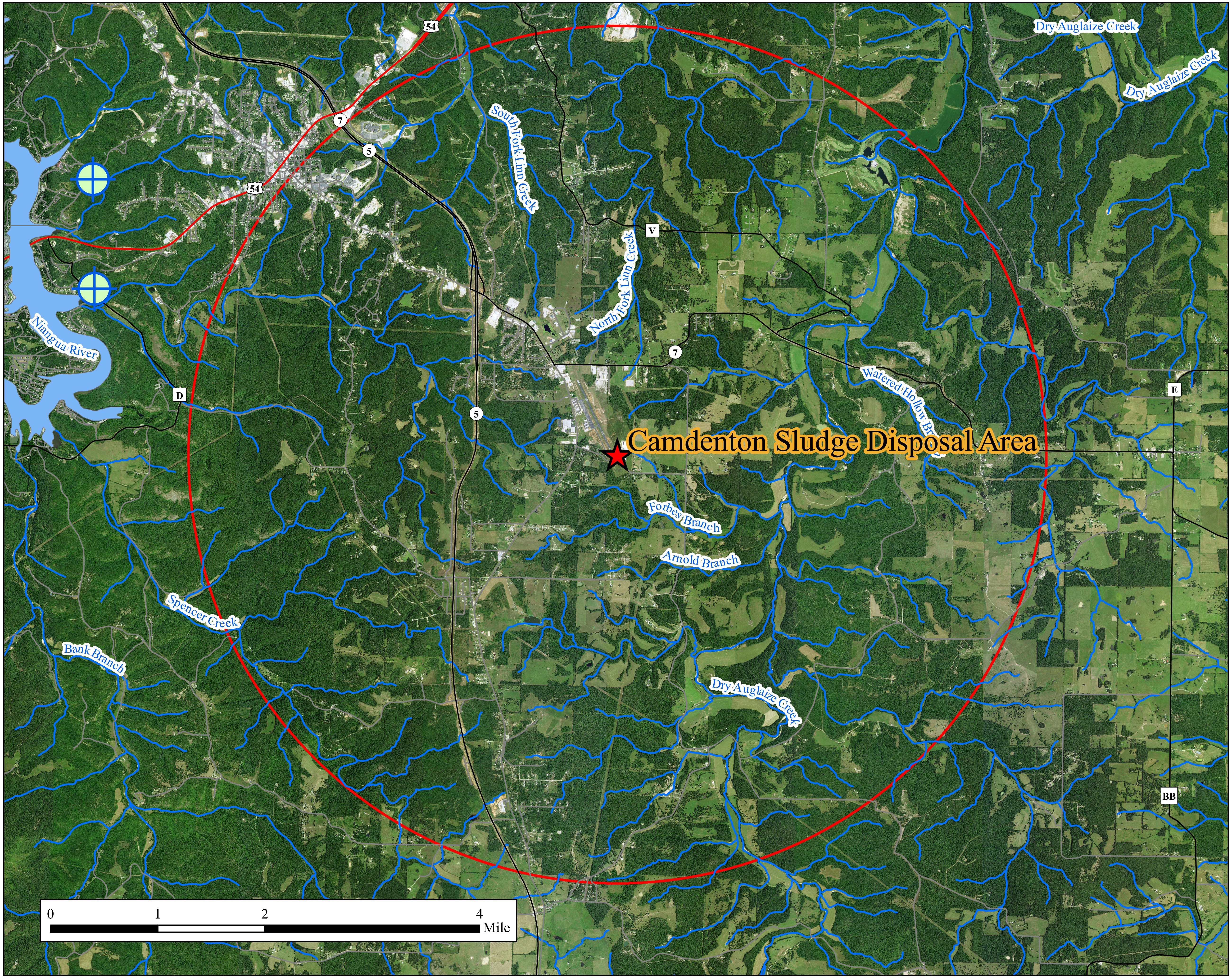
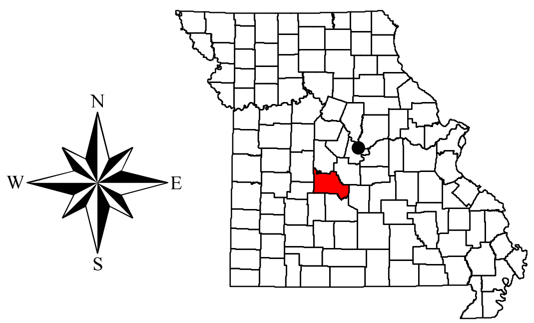


Figure 11: Site Reassessment Background Groundwater Wells Sampled Map October 19, 2017 Camdenton Sludge Disposal Area Site Camden County, Missouri

Legend

- Sludge Dispoal Area
- Background Wells Sampled
- Local Roads
- Federal Highway
- State Lettered Highway
- State Numbered Highway
- Rivers and Streams
- Lake of the Ozarks
- 4 Mile Site Radius



Created on: 5-24-17 by Keith Brown. This map is located at M/Superfund/Camdenton Sludge Disposal Site

Base Map: National Agriculture Imagery Program (NAIP) ortho photography. Flight Date: 2014
Data Sources: US Census 2010;
Missouri Department of Transportation

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MISSOURI DEPARTMENT OF NATURAL RESOURCES

APPENDIX B

TABLES

TABLE 1: SELECTED ANALYTICAL RESULTS FROM SOIL SAMPLES COLLECTED BY DAMES & MOORE IN CITY LAGOON # 3 ON OCTOBER 11, 1996			
Sample ID	**Depth**	**Analyte Detected**	**Concentration (in ppm)**
GP-1	4' - 6'	chloroform	0.20
		TCE	9.17
GP-2	4' - 5.5'	TCE	1.94
GP-3	4' - 5'	chloroform	0.0094
		cis-1,2-dichloroethene	0.0914
		TCE	not detected
GP-4	4' - 6'	TCE	not detected

TABLE 2: ANALYTICAL RESULTS FROM SOIL SAMPLES COLLECTED JANUARY 21, 1999 IN/NEAR THE CITY LAGOON #3

All results in parts per million (ppm) * soil saturation level substituted for ASL NA - not analyzed NL - not listed

Underlined results are those that are three times above background or above the detection limit if the background concentration is below the detection limit

	Hulett-01 4.5' - 5'	Hulett-02 6.5' - 7'	Hulett-03		Hulett-04 7.5' - 8'	Hulett-07 5.5' - 6'	Hulett-09 6' - 7'		Hulett-10 10.5' - 11'	SCDM		MO ASL	MO CALM C_{LEACH}
			3' - 4'	4.5' - 5.5'						Ref Dose	Canc. Scrn Conc.		
	991469	991470	991467	991468	991471	991472	991473	991474 (replicate)	991475 (background)				
METALS													
Arsenic, total	16.1	3.58	13.6	12.5	19.7	17.2	9.68	4.6	10.7	23	0.43	11	NL
Barium, total	150	62.4	244	519	750	257	103	132	203	5500	NL	3900	1650
Barium, TCLP	NA	NA	NA	0.442	0.628	NA	NA	NA	NA				
Cadmium, total	0.453	0.254	0.304	0.386	4.52	0.304	<0.2	0.204	0.651	39	NL	28	11
Chromium, total	74.9	31.9	55.5	61.3	68.9	73.3	58.2	39.8	62.7	390	NL	5600	38
Copper, total	39.9	15.7	33.6	37.5	64.3	38.8	6.47	8.56	36.8	NL	NL	NL	NL
Lead, total	116	38.1	118	951	325	80.1	39.1	61.8	94.2	NL	NL	240	NL
Lead, TCLP	<0.025	NA	0.0772	0.143	<0.025	<0.025	NA	NA	<0.025				NL
Mercury, total	0.102	<0.04	0.107	0.139	0.195	0.141	<0.04	<0.04	0.0947	23	NL	17	3.23
Nickel, total	43.3	12.5	49.4	69.6	90.1	36.2	9.76	12.4	32.5	1600	NL	1100	170
Selenium, total	<1	<1	<1	<1	<1	<1	<1	<1	<1	390	NL	280	4.37
Silver, total	<1	<1	<1	<1	<1	<1	<1	<1	<1	390	NL	280	255
VOCs													
Cis-1,2-dichloroethene	0.19	0.14	<0.025	<0.025	<0.025	0.11	<0.025	<0.025	<0.025	780	NL	490*	0.51
Trichloroethene	9.5	0.24	<0.025	<0.025	<0.025	0.12	<0.025	<0.025	<0.025	NL	58	340	0.097

TABLE 3: SELECTED ANALYTICAL RESULTS FROM SOIL SAMPLES COLLECTED IN/NEAR THE CAMDENDTON SLUDGE DISPOSAL AREA 1999 PA/SI

All results in parts per million (ppm) * soil saturation level substituted for ASL NA - not analyzed NL - not listed

Underlined results are those that are three times above background or above the detection limit if the background concentration is below the detection limit

Bolded results are those that are above background and exceed SCDM Benchmark and/or MO ASL

	Hulett-11	Hulett-12		Hulett-17	Hulett-18	Hulett-19			Hulett-20		SCDM Benchmark	MO ASL	MO CALM CLEACH
	0.5' – 1'	0.5' – 1'	8.5' – 9'	0.5' – 1.5'	5.5' – 6'	0.5' – 1'	7' – 7.5'	7' – 7.5'	0.5' – 1'	5.5' – 6'			
	991476 stockpile	991478 sludge	991477	991479	991480	991483 sludge	991481	991482 replicate	991484	991485			
									Background				
METALS													
Arsenic, total	7.46	8.78	4.98	5.97	7.08	19.7	4.94	5.76	8.74	34	0.0043	11	NL
Barium, total	170	280	139	105	93.7	253	69	82.6	206	195	5500	3900	1650
Cadmium, total	<0.2	0.782	<0.2	<0.2	0.216	1.55	<0.2	<0.2	<0.2	0.409	39	28	11
Chromium, total	33.1	**<u>1640</u>**	27.5	34.7	74.8	**<u>7830</u>**	38.8	43.9	38.1	110	390	5600	38
Chromium, TCLP	NA	0.0463	NA	NA	NA	0.041	NA	NA	NA	<0.004			
Copper, total	9.45	<u>1890</u>	10.4	6.79	7.12	<u>11200</u>	8.67	11.4	14.6	32	NL	NL	NL
Lead, total	21.8	66.2	19.2	17.3	19.4	<u>121</u>	13.5	16.6	26.3	67.6	NL	240	NL
Lead, TCLP	NA	NA	NA	NA	NA	<0.0411	NA	NA	NA	NA			
Mercury, total	<0.04	<u>0.314</u>	<0.04	<0.04	<0.04	<u>0.195</u>	<0.04	<0.04	0.0819	<0.04	23	17	3.23
Nickel, total	12.3	29.9	15.5	11.4	9.33	<u>129</u>	8.4	9.4	15.5	42.7	1600	1100	170
Selenium, total	<1	<1	<1	<1	<1	<u>1.03</u>	<1	<1	<1	<1	390	280	4.37
Silver, total	<1	<1	<1	<1	<1	<u>3.17</u>	<1	<1	<1	<1	390	280	255
VOCs													
Ethylbenzene	<0.025	<0.025	<0.025	<0.025	<0.025	<u>0.023</u>	<0.025	<u>0.018</u>	<0.025	<0.025	58	340	0.097
Toluene	<0.025	<0.025	<0.025	<0.025	<0.025	<u>0.03</u>	<0.025	<0.025	<0.025	<0.025	58	340	0.097
Total Xylenes	<0.025	<0.025	<0.025	<0.025	<0.025	<u>0.084</u>	<0.025	<0.025	<0.025	<0.025	58	340	0.097

Table 4: Stratigraphic Column for the Camdenton Sludge Disposal Area, Camden County

System	Aquifer Group	Approximate Site – Specific Thickness (ft.)	Formation	Hydraulic Conductivity (cm/sec)	Regional Thickness (ft.)	Dominant Lithology	Water-bearing Character
Quaternary		10	Colluvium and residuum		0-90	Regolith of residual clay, sand, chert pebbles and cobbles	May contain small amounts of perched water.
Ordovician	Ozark Aquifer	50	Roubidoux Formation	10^{-3}	0-90	Clayey residuum, sandstone and sandy dolomite	Not present in sufficient thickness in the Camdenton area to produce usable quantities of water.
		280	Gasconade Dolomite	10^{-6}	300-385	Cherty dolomite, minor sandstone, and shale	Yields moderate to large quantities of water to wells. Yields range from 20 to 75 gpm. Less-permeable Upper Gasconade may act as a leaky confining unit.
		25	Gunter Sandstone Member	10^{-4}	10-45	Sandstone	Contributes moderate to large quantities of water. Most wells open to other formations.
Cambrian		550?	Eminence Dolomite	10^{-5}	240-635	Cherty dolomite	Yields 6-100 gpm, the average being about 20 gpm
		50?	Potosi Dolomite	10^{-4}	30-330	Dolomite; contains abundant quartz druse	Yields large quantities of water to wells. Yields range from 100 to 750 gpm.
	St. Francois Confining Unit	80	Derby-Doerun Dolomite	10^{-7}	80?-215	Shaley dolomites and shale	Reliable aquitard.
		80	Davis Formation	10^{-7}	50-380?		
	St. Francois Aquifer	90	Bonneterre Formation	10^{-5}	85-200	Dolomite and limestone	Generally used only in outcrop areas. May contribute additional 100-200 gpm to wells open to other formations.
		300	Lamotte Sandstone	10^{-5}	140-300	Sandstone and arkosic conglomerate	
Precambrian	Basement Confining Unit					Igneous and metamorphic rocks	Does not yield water to wells in this area

TABLE 5: DRINKING WATER WELLS REGISTERED WITH THE DEPARTMENT WITHIN A 4-MILE RADIUS OF THE CAMDENTON SLUDGE DISPOSAL AREA SITE			
Miles From Site	Number of Public Wells	Number of Private Wells	Estimated Population Served
0 – 1/4	0	1	2
1/4 – 1/2	0	5	10
1/2 - 1	3	17	600
1-2	2	46	993
2-3	4	104	453
3-4	6	99	3257
TOTAL	**16**	**272**	**5315**

TABLE 6: SELECTED ANALYTICAL RESULTS FOR DRINKING WATER WELL SAMPLES COLLECTED OCTOBER 2, 2017
CAMDENTON SLUDGE DISPOSAL AREA SITE, CAMDEN COUNTY, MISSOURI

- All values listed in parts per billion (ug/l) unless otherwise noted.
- NL denotes benchmark value not listed in reference source.
- Sample results in bold exceed three times background values
- Sample results in shaded cells exceed the lowest of the SCDM benchmark or action level values

Laboratory Number	**AD08851**	**AD08852**	**AD08853**	**AD08854**	**AD08855**	**AD08856**	**AD08857**	**AD08858**	**AD08859**	**AD08860**	**AD08861**	**AD08862**	**AD08863**	**AD09231**				
Sample Comments	**private well**	**private well**	**private well**	**private well**	**private well**	**public well**	**private well**	**private well**	**private well**	**private well**	**private well**	**private well**	**private well**	**background well***	**SCDM[1]**	**EPA RML[2]**	**EPA SL[3]**	**MO WQS[4]**
Location ID	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**109 Dup**	**110**	**111**	**112**	**118**				
Water Quality Indicators																		
Field Temperature °C	16.7	17.7	18.4	16.8	16	16.5	15.6	16.1	16.1	NA	16	16.3	17.6	15.5	NL	NL	NL	NL
pH	7.56	7.64	7.59	7.52	7.56	7.6	7.43	7.6	7.65	NA	7.47	7.58	7.78	7.09	NL	NL	NL	NL
Specific Conductivity, umhos/cm	535	473	496	475	445	456	452	420	525	NA	544	475	507	703	NL	NL	NL	NL
Metals																		
Barium, dissolved	53	45.2	45.2	46.8	36.3	49	42.4	39.9	81.4	81.4	59.1	43.1	47.6	52.2	2000	1100	3800	2000
Barium	56.7	46.6	46.7	47.5	38.1	48.8	42.5	40.6	82.1	83.2	60	44.7	47.5	51	2000	1100	3800	2000
Chromium, dissolved	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	100	NL	NL	100
Chromium, total EPA method 200.7	<1.25	<1.25	<1.25	<1.25	<1.25	**3.25**	<1.25	<1.25	<1.25	<1.25	<1.25	<1.25	<1.25	<1.25	100	NL	NL	100
Copper, dissolved	1.18	2.17	7.35	<1	1.89	3.19	3.39	1.4	1.31	1.26	1.13	4.44	2.53	3.07	1300	2400	800	1300
Copper	**82.1**	2.4	**9.11**	<1.25	2.13	3.14	4.19	1.63	1.54	1.72	1.39	**13.1**	6.7	2.49	1300	2400	800	1300
Lead, dissolved	<1	<1	<1	<1	<1	**1.76**	<1	<1	<1	<1	<1	**4.89**	<1	<1	15	15	15	15
Lead	**6.95**	<1.25	<1.25	<1.25	<1.25	**4.75**	<1.25	<1.25	<1.25	<1.25	<1.25	**63.6**	<1.25	<1.25	15	15	15	15
Zinc, dissolved	**29**	**16.4**	**402**	**104**	**12.7**	**238**	**45.6**	6.66	**57.8**	**57.8**	9.14	**22.9**	**132**	3.36	NL	1800	6000	5000
Zinc	**51.6**	**13.6**	**384**	**92**	**9.58**	**225**	**38.1**	4.74	**49.9**	**49.5**	7.82	**20.4**	**109**	3.14	NL	1800	6000	5000
Volatile Organic Compounds (VOCs)																		
Trichloroethylene (TCE)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	5	2.8	0.49	5

[1] SCDM - Superfund Chemical Data Matrix, Maximum Contaminant Level (MCL) for drinking water, November, 2017. Risk level 10^{-6}, hazard quotient =1.

[2] EPA RML - Removal Management Level November, 2017. Lower of cancer and non-cancer values. Risk level 10^{-4}, hazard quotient=1

[3] EPA SL - EPA Regional Screening Levels tap water, November 2017. Lowest of carcinogenic and non-carcinogenic value. Risk level 10-6, hazard quotient =1.

[4] MO WQS - Missouri Water Quality Standards, groundwater/drinking water use catagories, Missouri Code of State Regulations, 10 CSR 20-7.031, June, 2015.

* Background well was sampled on 10-19-2017

TABLE 7: SELECTED ANALYTICAL RESULTS FOR DRINKING WATER WELL SAMPLES COLLECTED OCTOBER 19, 2017
CAMDENTON SLUDGE DISPOSAL AREA, CAMDEN COUNTY, MISSOURI

- All values listed in parts per billion (ug/l) unless otherwise noted.
- NL denotes benchmark value not listed in reference source.
- NA denotes not analyzed
- Sample results in shaded cells exceed the lowest of the SCDM benchmark or Action Level values
- Sample results in bold exceed three times background values

Sample Laboratory Number	AD09226	AD09232	AD09224	AD09229	AD09233	AD09225	AD09234	AD09235	AD09227	AD09228	AD09220	AD09221	AD09223	AD09231	AD09230	AD15268	AD15267	SCDM[1]	EPA RML[2]	EPA SL[3]	MO WQS[4]
Location ID	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111(F)***	**111**	**112**	**118**	**123**	**123**	**123**				
Sample comments	**Private well**	**Private well**	**Private well**	**Private well**	**Private well**	**Public well**	**Private well**	**Private well**	**Private well**	**Private well**	**Private well**	**Private well**	**Private well**	**Background well**	**Background well**	**pitcher filter****	**refrigerator filter****				
Water Quality Indicators																					
Field Temperature, °C	15.4	17	16.7	16.1	15.2	15.7	15.2	15.1	14.8	15	16.7	14.6	14.7	15.5	15.6	15.6	13.7	NL	NL	NL	NL
pH	7.42	7.56	7.55	7.48	7.45	7.53	7.36	7.52	7.5	7.49	7.24	7.16	7.29	7.09	7.43	7.43	7.46	NL	NL	NL	NL
Specific Conductivity, umhos/cm	506.3	427.8	455.4	462.1	460.1	454	438.6	413.9	514.6	534.5	469.1	461.5	449.3	703	575	575	560	NL	NL	NL	NL
Metals																					
Barium, dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<1	44.9	NA	52.2	56.8	NA	NA	2000	11000	3800	2000
Barium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<1.25	44.3	NA	51	54.6	NA	NA	2000	11000	3800	2000
Chromium, hexavalent	NA	NA	NA	NA	NA	.31 (d)	NA	NA	NA	NA	NA	NA	NA	.013 (d)	.081 (d)	NA	NA	NL	3.5	0.035	NL
Chromium, EPA method 200.8	1.73 (k)	1.59 (k)	1.37 (k)	1.53 (k)	1.58 (k)	1.77 (k)	3.99 (k)	1.75 (k)	1.39 (k)	1.64 (k)	1.33 (k)	1.82 (k)	1.42 (k)	2.42 (k)	1.47 (k)	NA	NA	100	NL	NL	100
Chromium, EPA method 200.7	<1.25	<1.25	<1.25	<1.25	<1.25	**4.41**	<1.25	<1.25	<1.25	<1.25	<1.25	<1.25	<1.25	<1.25	<1.25	NA	NA	100	NL	NL	100
Copper, dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10.4	3.67	NA	3.07	1.19	NA	NA	1300	2400	800	1300
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9.26	12.9	NA	2.49	1.58	NA	NA	1300	2400	800	1300
Lead, dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<1	3.44	NA	<1	22.5	NA	NA	15	15	15	15
Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<1.25	28.8	NA	<1.25	23.7	10.7	<0.5	15	15	15	15
Zinc, dissolved	**25.7**	**15.4**	**334**	**56.1**	10.3	**218**	**22.9**	**10.9**	**51.6**	5.4	4.08	**16.2**	**160**	3.36	29.3	NA	NA	NL	18000	6000	5000
Zinc	**20**	**17.2**	**342**	**53.5**	**9.6**	**342**	**29.3**	**10.6**	**52.8**	**5.4**	1.7	**22**	**161**	3.14	29.8	NA	NA	NL	18000	6000	5000

[1] SCDM - Superfund Chemical Data Matrix, Maximum Contaminant Level (MCL) for drinking water, November, 2017. Risk level 10^{-6}, hazard quotient =1.

[2] EPA RML - Removal Management Level, 2014. Lower of cancer and non-cancer values. Risk level 10^{-4}, hazard quotient=1

[3] EPA SL - EPA Regional Screening Levels tap water, November 2017. Lowest of carcinogenic and non-carcinogenic value. Risk level 10-6, hazard quotient =1.

[4] MO WQS - Missouri Water Quality Standards, groundwater/drinking water use catagories, Missouri Code of State Regulations, 10 CSR 20-7.031, June, 2015.

d - Analyzed by Contract Laboratory

k - Estimated value, matrix interference

* Location 111F denotes a sample collected from an indoor faucet at location 111

** Samples collected on 2-13-18 and analyzed by EPA SW 846 6020 to assess lead risk after filtration

TABLE 8: CALCULATION OF SAMPLE/SAMPLE DUPLICATE RELATIVE PERCENT DIFFERENCE (RPD) GROUNDWATER SAMPLES COLLECTED OCTOBER 2, 2017 CAMDENTON SLUDGE DISPOSAL AREA SITE, CAMDEN COUNTY, MISSOURI

All results are in (mg/kg ug/l) unless otherwise noted

Sample ID	**173389**	**173390**	**RPD**
Laboratory Number	**AD08859**	**AD08860**	
Metals			
Arsenic, dissolved	<1	<1	NA
Arsenic - Total	<1.25	<1.25	NA
Barium, dissolved	81.4	81.4	0.0
Barium	82.1	83.2	0.7
Chromium, dissolved	<1	<1	NA
Chromium, total	<1.25	<1.25	NA
Copper, dissolved	1.31	1.26	1.9
Copper	1.54	1.72	5.5
Lead, dissolved	<1	<1	NA
Lead	<1.25	<1.25	NA
Zinc, dissolved	57.8	57.8	0.0
Zinc	49.9	49.5	0.4
Volatile Organic Compounds (VOCs)			
Trichloroethylene (TCE)	<0.5	<0.5	NA

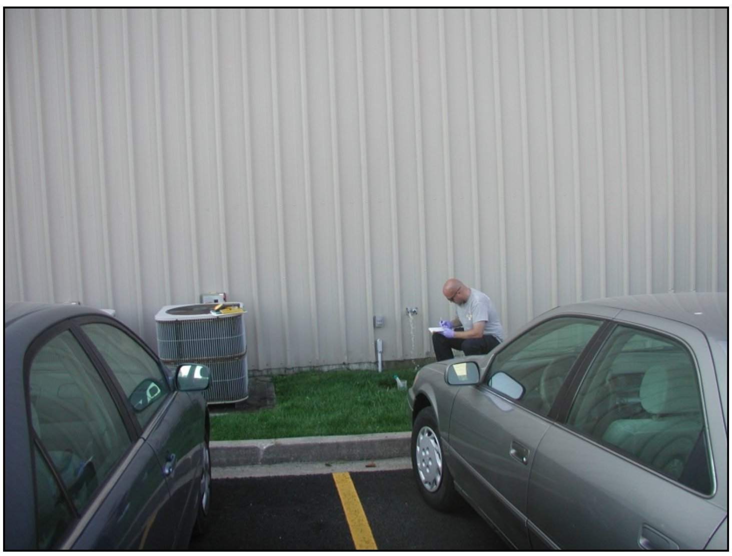
TABLE 9: ESTIMATED POPULATION WITHIN A 4-MILE RADIUS OF THE SITE	
RADIUS	POPULATION
ON-SITE	0
0 - 1/4	3
1/4 - 1/2	23
1/2 - 1	122
1 - 2	579
2 - 3	587
3 - 4	1,242
TOTAL	2,556

APPENDIX C

PHOTOGRAPHIC LOG

Photograph 1
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph of well spigot at Location 101 during sampling. Photo taken facing north.



Photograph 2
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

View of well spigot at Location 102 during 5 minute purge prior to sampling. Photo taken facing south.

Photograph 3
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

Picture of Location 103 during sampling. Photo taken facing south.

Photograph 4
Camdenton Sludge Disposal Area Site
Camdenton , Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph of well Spigot (with hose attached) for location 104. Photograph was taken facing north.

Photograph 5
Camdenton Sludge Disposal Area Site
Camdenton , Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

Picture depicts sampling preparations for well spigot at location 105. Photograph was taken facing east.

Photograph 6
Camdenton Sludge Disposal Area Site
Camdenton , Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph of pump station for Camden County PWSD #2 Well #1 (Location 106-Airport Well).

Photograph 7
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

View of Camden County PWSD #2 Well #2 (Location 106) pump house. Photograph was taken facing west.

Photograph 8
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

Picture of well pump house at Location 107. Photograph was taken facing south.

Photograph 9
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph of well cap at Location 108. Well stem and portable GPS unit are in the foreground. Photograph was taken facing south.

Photograph 10
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph of Location 109 during sampling. Well shaft is within stone structure near propane tanks. Photograph was taken facing east.

Photograph 11
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

Picture of house at Location 110. Photograph was taken facing south.

Photograph 12
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph of pump house at Location 111. Well casing and pump are enclosed in the portion of the building with the door ajar. Photograph was taken facing south.

<u>Photograph 13</u>
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/02/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph well spigot where sample was collected at Location 112. Photograph was taken facing south.

<u>Photograph 14</u>
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Picture of ESP staff resampling the well at Location 111. Photograph was taken facing south.

<u>Photograph 15</u>
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph of ESP well head and water tank at Location 111 during resampling.

Photograph 16
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Picture of well spigot at Location 111 during resampling. Photograph was taken facing south.

Photograph 17
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Picture of ESP staff monitoring parameters from the well spigot at Location 103 during resampling. Photograph was taken facing south.

Photograph 18
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph depicts ESP staff collecting water quality parameters prior to resampling of Camden County Public Water Supply District #2 Well #1 (Location 106). Photograph was taken facing north.

Photograph 19
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

View of ESP conducting resampling of well at Location 101. Photograph was taken facing east.

Photograph 20
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph depicts ESP staff conducting resampling of well at Location 109. Photograph was taken facing east.

Photograph 21
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Picture shows ESP staff accessing well spigot (attached to outer wall of home) for resampling at Location 110. Photograph was taken facing south.

Photograph 22
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph of well spigot at Location 104 during resampling. Hose was connected during purging and was disconnected prior to actual sampling. Photograph was taken facing north.

Photograph 23
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Picture of well spigot at Location 123 during initial round of sampling. Photograph was taken facing west.

Photograph 24
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph of well spigot at Location 118 during initial round of sampling. Photograph was taken facing west.

Photograph 25
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Picture shows an up close view of the well spigot at Location 102 during resampling. Photograph was taken facing south.

Photograph 26
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Photograph of well spigot at Location 105 during resampling. Hose was attached during purging and was disconnected prior to actual sampling. Photograph was taken facing north.

Photograph 27
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2018 by
Keith Brown,
DEQ, HWP, SF

Well housing for location 107 is depicted in the foreground of photograph. ESP staff are conducting resampling in the background.

Photograph 28
Camdenton Sludge Disposal Area Site
Camdenton, Camden County, MO
Photo taken 10/19/2017 by
Keith Brown,
DEQ, HWP, SF

Picture shows an up close view of the well spigot at Location 108 during resampling. Well spigot is turned on for purging until water quality parameters stabilize in this photograph. Photograph was taken from back porch of home

APPENDIX D

SAMPLING DOCUMENTATION

Site Reassessment Sampling Report

Camdenton Sludge Disposal Area Site

Camdenton, Missouri

Camden County

October 2nd and 19th, 2017

February 13, 2018

Prepared For:

Missouri Department of Natural Resources

Division of Environmental Quality

Hazardous Waste Program

Prepared By:

Missouri Department of Natural Resources

Division of Environmental Quality

Environmental Services Program

Table of Contents

1.0 Introduction

As authorized under the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986, the Missouri Department of Natural Resources (MoDNR), Hazardous Waste Program (HWP), Site Assessment Unit (SAU) and MoDNR, Environmental Services Program (ESP), Field Services Unit (FSU) conducted a Site Reassessment (SR) at the Camdenton Sludge Disposal Area site. The Camdenton Sludge Disposal Area is the location of a disposal site for municipal sewage sludge that contained industrial effluent and is suspected to contain contaminants that could be released into the environment.

The objective of this investigation was to re-assess potential threats to human health and the environment at the site. The investigation included collection of groundwater samples from private and public drinking water wells in the vicinity of the former Camdenton Sludge Disposal Area at the Camdenton Municipal Airport.

2.0 Site Information

2.1 Location

The Camdenton Sludge Disposal Area site is located on Old South 5 in the southeast portion of the Camdenton Memorial Airport property. The site is located on city property, but is actually three miles southeast of Camdenton city limits (appendix A). Geographic coordinates for the site are 37°58'08.7" and 92°41'14.7". The sludge disposal area has been previously identified at the south east side of the airport and a portion of the original area has since been covered by pavement during an expansion of the runway. The site is approximately four miles from three other sites in Camdenton with known soil and groundwater Trichloroethylene (TCE)

contamination; Hulett Lagoon (where the sludge originated), former Modine Manufacturing facility, and the City of Camdenton's Mulberry Well.

2.2 Operational and Site History

The site is a municipal airport for the City of Camdenton. The full name of the airport is the Camdenton Memorial –Lake Regional Airport- KOZS. Regional flights serve the Lake of the Ozarks regional area. In 1989 the City of Camdenton land applied sewage sludge from Hulett Lagoon which received industrial effluent from a metal parts manufacturing facility. The waters and sludge from Hulett Lagoon have been found to contain VOCs and metals. The sludge was applied to an area at the south end of the airport south and east of the runway.

2.3 Previous Investigations

The department's Superfund site assessment unit completed a Combined Preliminary Assessment/Site Inspection (PA/SI) Report on the Camdenton Sludge Disposal Area site on March 30, 1999. Soil borings were collected in the sludge disposal area of the airport. Total chromium, copper, lead and nickel were detected above background concentrations in the soil borings collected within the sludge material, but no TCE was detected in any of the soil cores. Only total chromium level exceeded the Superfund Chemical Data matrix (SCDM) benchmarks. No hexavalent chromium analysis was conducted. None of the soil samples were characterized as characteristically hazardous waste using the Toxicity Characteristic Leaching Procedure (TCLP). Ethylbenzene, toluene, and total xylenes were detected in soil cores at concentrations above background levels, but below health based benchmarks.

Groundwater samples were also collected from private and public drinking water wells in the area. Although there was an initial positive detection of TCE in a pair of groundwater samples from two private wells near the disposal site, repeated sampling efforts were unable to duplicate

these results and it was determined that there was no significant threat from TCE in the groundwater at that time.

3.0 Data Quality Objectives

To help ensure precise, accurate, representative, complete, and comparable data, all field work and analyses was conducted in accordance with the Quality Assurance Project Plan (QAPP) for Pre-Remedial/Pre-Removal and Targeted Brownfields Site Assessments Revision 7, December 7, 2012, and ongoing. The QAPP describes the general data quality objectives (DQO) for site assessment investigations conducted by the HWP and ESP.

4.0 Field Activities

4.1 Sample Collection

Public and private well samples were collected from a point closest to the well head as possible. The tap was opened at a high flow for five minutes. After five minutes, specific conductivity, pH, and temperature readings were collected. The tap continued to run for an additional three minutes and field measurements were collected again. If all the parameters were considered stable, (pH within 0.2 units, temperature and specific conductivity within +/- 10%) a sample was collected. If water quality parameters were not within stable range then the tap continued to operate for an additional three minutes and this would be repeated until stabilization occurred. Groundwater samples collected for dissolved metals analysis were filtered in the field prior to submission to the laboratory. Each property was given a unique location identification number. Each sample was also given a unique sample number; both numbers were recorded on chain of custody forms and the samples were stored on ice in coolers until submission to the laboratory for analysis.

Locational data was collected at each wellhead using a Trimble GeoExplorer handheld global positioning system (GPS) and a minimum logging time of 60 seconds.

4.2 Analysis Requested

The samples submitted to the department's laboratory for the 10/2/17 sampling event were analyzed for volatile organic contaminants using method 524.2 and for total and dissolved metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn) using method 200.8. Due to matrix interferences that were discovered on the dissolved chromium and zinc analysis (see section 7.0 Observations), the samples were reanalyzed for chromium (a contaminant of concern) only on 10/27/17 using method 200.7.

As a result of the unusual dissolved chromium results from the 10/2/17 event, all of the sample locations were resampled on 10/19/17. These samples were analyzed for total and dissolved metals (Cr, Zn) only, using methods 200.8 and 200.7 for dissolved Cr. Also one of the original sample locations (Loc. ID 106) was analyzed for hexavalent chromium because the total Cr result from 10/2/17 was above 3.5 ug/L. The two new (background) locations were analyzed for total and dissolved metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn) and hexavalent chromium.

The samples submitted for the 2/13/18 sampling event were analyzed for total metals (Pb) only.

4.3 Number of Samples Collected

Refer to the tables below for sample information. Due to reasons explained below in the observation section, three sampling events took place for this site. During the first sampling event, twelve samples were collected. Fifteen samples were collected during the second sampling event. Four samples were collected for the third sampling event.

4.4 Chain-of-Custody

All samples were entered onto an ESP Chain of Custody (COC) form to be relinquished to a sample custodian at the department's Environmental Laboratory for analysis.

5.0 Quality Control (QC)

5.1 Field Decontamination

Clean disposable latex gloves were worn by sampling personnel and clean equipment was utilized for each sample location to minimize the possibility of cross-contamination.

5.2 Quality Assurance/Quality Control (QA/QC) Samples

The following samples were collected as part of the quality control/quality assurance procedures for the investigation.

5.2.1 Duplicate Groundwater Sample

One duplicate groundwater sample was collected during each of the first two sampling events only. The third sampling event did not have a duplicate sample collected. The duplicate sample was collected alongside its true sample using the same technique as for the true sample. The duplicate sample was assigned a unique sample number, was entered onto the chain-of-custody form as "blind duplicate", and was submitted for the same analytes as its true sample.

5.2.3 Trip Blank

One trip blank sample consisting of analyte-free water was prepared in the laboratory, taken to the field, and accompanied samples collected and transported back to the laboratory. The trip blank received a numbered label, was entered onto the chain-of-custody form, and submitted for volatile organics analyses. The trip blank sample was only utilized during the 10/2/17 sampling event. VOCs analysis was not part of the 10/19/17 or the 2/13/18 sampling events.

5.2.4 Filter Blank

One filter blank sample was collected during the second sampling event. Analyte-free water was prepared in the laboratory, taken to the field, and pumped through a 0.45 micron groundwater

filter typically used for collecting groundwater samples for dissolved metals analysis. 500ml-1000ml of the analyte free water was passed through the filter before the sample was collected. The filter blank sample received a number label, was entered on the chain-of-custody form, and submitted for dissolved metals analysis.

6.0 Investigation Derived Wastes (IDW) Plan

IDW generated during private drinking well evacuation was allowed to drain onto the ground. Disposable personal protective equipment and disposable sampling equipment were generally handled as solid waste, containerized, and properly disposed.

7.0 Observations

Site work began on 10/2/17. This sampling event was conducted in conjunction with the Dawson Metal Products Camdenton Facility #2 sampling event. The sampling team for this site consisted of Sean Counihan (ESP) and Keith Brown the HWP project manager. The sampling team began site work around 0815. Sampling went well. No anomalies were experienced during sampling and sampling was completed around 1400 hours. The samples were submitted to the ESP sample receiving for analysis.

Once the analytical results were complete, an issue arose when it was observed that the results for dissolved chromium were higher than what was reported in total chromium. All aspects of sampling were questioned (procedure, equipment used) and the results could not be duplicated in the lab.

As a result, it was decided to resample all of the drinking water wells sampled on 10/2/17 with some changes. Two additional properties were selected, away from the area of influence of the

site, to be used as background samples. Additionally, one property that was sampled originally had lead levels that were elevated. Aside from the resample from the outside spigot, a new sample was collected from inside the home to gauge actual exposure after the water is run through a water softener treatment system that is in the home. Also, an additional container (for all samples) was collected and held for possible hexavalent chromium analysis. Location IDs 106, 118, and 123 were selected for the hexavalent chromium analysis.

The new sampling event was conducted on 10/19/17 by Ken Hannon and Eric Sappington with ESP and Keith Brown with HWP. No issues with sampling occurred. They began around 0800 hours and sampling was completed around 1600 hours. These samples were submitted to the lab on 10/20/17.

Preliminary results of these new samples again showed higher amounts of dissolved chromium over total chromium. The CAS laboratory staff began investigating the analytical method and analytical equipment used. It was discovered (a detailed explanation is below in appendix B) that a matrix interference occurred when using EPA method 200.8 for chromium resulting in a false positive.

The original samples collected on 10/2/17 were reanalyzed for chromium only, using EPA method 200.7. The new set of samples collected on 10/19/17 was also analyzed using method 200.7

The analytical results from one of the background locations (a new location) chosen for the 10/19/17 sampling event (Location ID 123) showed unexpected elevated lead levels. On 2/13/18 this location was resampled to verify the results of the original sample. A sample was again collected from the outside tap, along with samples from the kitchen sink, from the filtered refrigerator water dispenser, and from a Brita water filtration pitcher system. The home itself

does not have a filtration/water softening system. The refrigerator sample had 1000 milliliters of water purged from the system to get fresh water in the line. The Brita sample was collected directly from the pitcher.

8.0 Data Reporting

Please refer to Appendix B for analytical results of samples collected. The original 10/2/17 results are reported as an addendum showing the false positive and the new EPA method 200.7 result. The results of the resampling effort on 10/19/17 and 2/13/18 follow the original results.

SIGNATURES

Prepared by: ______________________________

Sean Counihan
Environmental Specialist
Field Services Unit
Environmental Services Program

APPROVED
By Eric Sappington at 9:31 am, Apr 19, 2018

Approved by: ______________________________

Eric J. Sappington
Unit Chief
Field Services Unit
Environmental Services Program

ES:smc

c: Keith Brown, HWP

Table 1

Camdenton Sludge Disposal Area Site, Camden County, Missouri, October 2nd sampling event

Groundwater Sample Collection Data			
Sample Number	**Date Collected**	**Time Collected**	**Location Collected/Description**
173380	9/29/17	1500	Trip Blank
173381	10/2/17	0842	Loc. ID 101, collected from spigot in front of building
173382	10/2/17	0915	Loc. ID 102, collected from spigot of wall of south building
173383	10/2/17	0940	Loc. ID 103, collected from spigot in carport
173384	10/2/17	1012	Loc. ID 104, collected from spigot in front of outbuilding
173385	10/2/17	1038	Loc. ID 105, collected from spigot along driveway
173386	10/2/17	1108	Loc. ID 106, collected from PWSD #2 off city well piping
173387	10/2/17	1135	Loc. ID 107, collected from spigot off well house in front yard
173388	10/2/17	1200	Loc. ID 108, collected from spigot on back of house
173389	10/2/17	1222	Loc. ID 109, collected from spigot of stone well house
173390	10/2/17	0000	Blind Duplicate of Loc. ID 109, sample number 173389
173391	10/2/17	1250	Loc. ID 110, collected from spigot near horse trough
172314	10/2/17	1330	Loc. ID 111, collected from spigot off well house
172315	10/2/17	1355	Loc. ID 112, collected from spigot near well head

Table 2

Camdenton Sludge Disposal Area Site, Camden County, Missouri, October 19th resampling event

Groundwater Sample Collection Data			
Sample Number	**Date Collected**	**Time Collected**	**Location Collected/Description***
173977	10/19/17	0810	Filter Blank
173978	10/19/17	0825	Loc. ID 111, collected from inside house kitchen sink faucet
173979	10/19/17	0852	Loc. ID 111, collected from spigot outside near well head
173980	10/19/17	0000	Blind Duplicate of Loc. ID 111, sample number 173979
173981	10/19/17	0922	Loc. ID 112, collected from spigot nearest well head
173982	10/19/17	0944	Loc. ID 103, collected from spigot in front of the house
173983	10/19/17	1009	Loc. ID 106, collected from PWSD #2 spigot on well head
173984	10/19/17	1040	Loc. ID 101, collected from spigot in front of the building
173985	10/19/17	1100	Loc. ID 109, collected from spigot on well head
173986	10/19/17	1140	Loc. ID 110, collected from spigot on the front of house next to well head
173987	10/19/17	1205	Loc. ID 104, collected from spigot near work shed
173988	10/19/17	1334	Loc. ID 123, background sample collected from spigot in front of the house
173989	10/19/17	1400	Loc. ID 118, background sample collected from spigot on the side of the house
173990	10/19/17	1440	Loc. ID 102, collected from spigot in front of building
173991	10/19/17	1500	Loc. ID 105, collected from spigot next to well head
173992	10/19/17	1522	Loc. ID 107, collected from spigot on well house
173993	10/19/17	1545	Loc. ID 108, collected from spigot on the back of the house

*Locational data provided is as described by Ken Hannon

Table 3

Camdenton Sludge Disposal Area Site, Camden County, Missouri, February 13, 2018 resampling event

Groundwater Sample Collection Data			
Sample Number	**Date Collected**	**Time Collected**	**Location Collected/Description**
181072	2/13/2018	1223	Loc. ID 123, collected from spigot on the front of the house
181073	2/13/2018	1246	Loc. ID 123, collected from kitchen sink tap
181074	2/13/2018	1249	Loc. ID 123, collected from filtered refrigerator water dispenser
181075	2/13/2018	1252	Loc. ID 123, collected from a Brita water filtration pitcher system

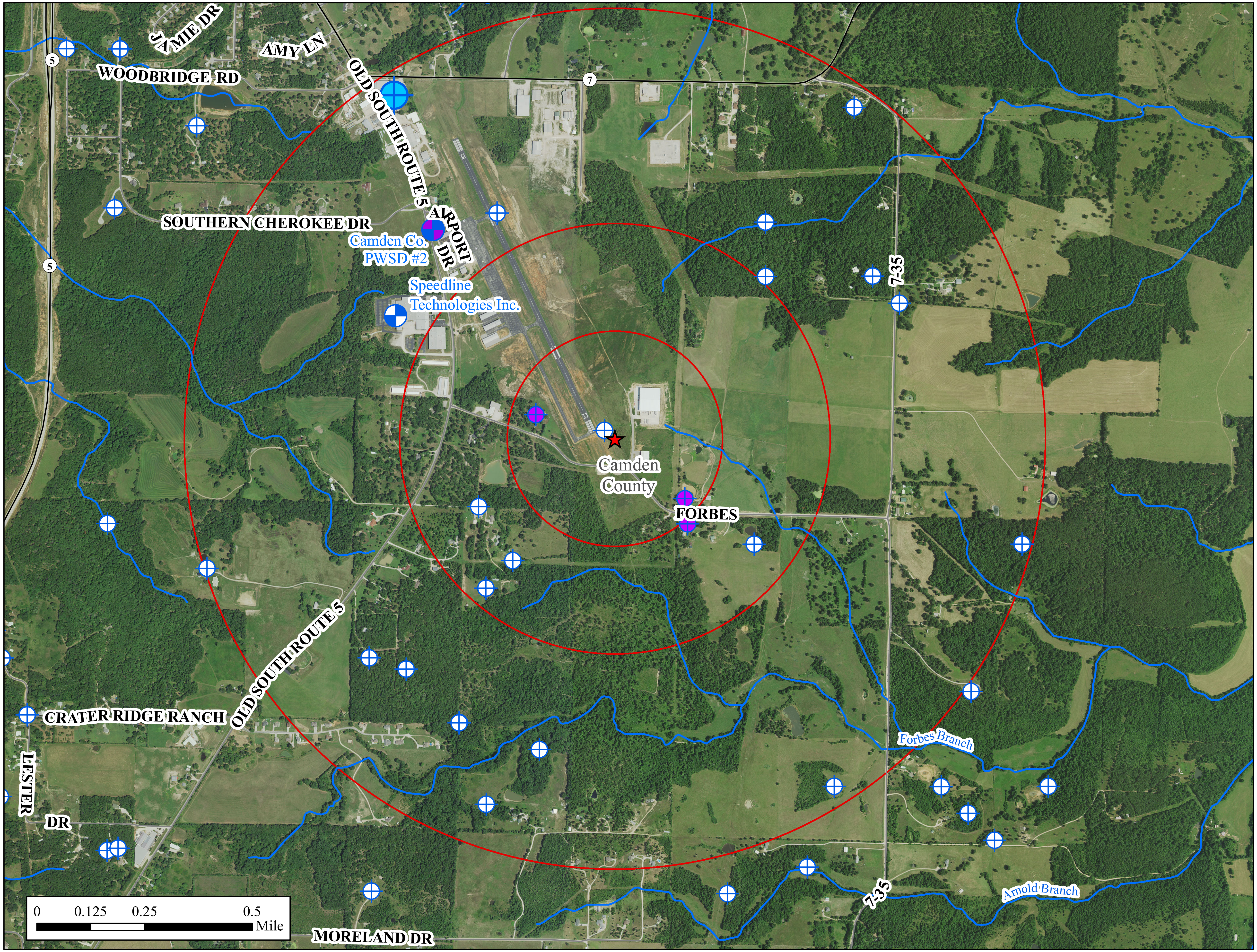
APPENDIX A

Site Map/Sample Locations Map

Camdenton Sludge Disposal Area Site

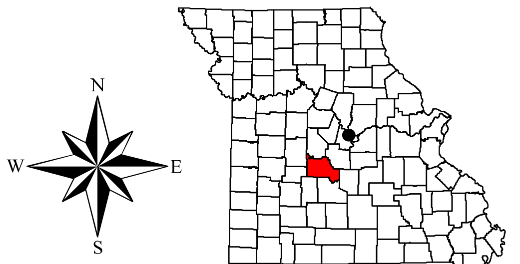
Camdenton, MO

Figure 1: Site Location Map
Camdenton Sludge Disposal Area Site
Camdenton Memorial Airport
Camden County, Missouri



Legend

- Concerned Citizen's well
- Previously Sampled Private Wells
- Previously Sampled Public Well
- Center of Operations
- Private Drinking Water Wells
- Public Wells
- Local Roads
- State Lettered Highway
- Rivers and Streams
- 1 Quarter, 1 half and 1 mile Buffers



Created on: 5-24-17 by Keith Brown. This map is located at M/Superfund/Camdenton Sludge Disposal Site

Base Map: National Agriculture Imagery Program (NAIP) ortho photography. Flight Date: 2014
Data Sources: US Census 2010;
Missouri Department of Transportation

Although data sets used to create this map have been compiled by the Missouri Department of Natural Resources, no warranty, expressed or implied, is made by the department as to the accuracy of the data and related materials. The act of distribution shall not constitute any such warranty, and no responsibility is assumed by the department in the use of these data or related materials.

MISSOURI DEPARTMENT OF NATURAL RESOURCES

APPENDIX B

Analytical Results and Lab Error Explanation

Camdenton Sludge Disposal Area Site

Camdenton, MO

MEMORANDUM

DATE: November 8, 2017

TO: Valerie Wilder, Environmental Manager
Hazardous Waste Program

THROUGH: Brian Allen, Director
Environmental Services Program

FROM: Kevin Thoenen, Laboratory Manager
Environmental Services Program

SUBJECT: Matrix Interference for Chromium Analysis

On October 2, 2017, Environmental Services Program (ESP) staff collected water samples from drinking water sources in the Camdenton area as a part of the Camdenton Sludge Disposal Site study (Job Code: NJ00CAMD). The samples were submitted to the Chemical Analysis Section (CAS) for total and dissolved Arsenic, Barium, Cadmium, Chromium, Copper, Selenium, Lead, and Zinc by EPA Method 200.8 along with Volatile Organic Compounds by EPA Method 524.2. They were assigned CAS laboratory numbers AD08851 through AD08863 (13 samples). The CAS conducted the dissolved metals analysis directly from a field-filtered, acid-preserved aliquot collected from each water source. For the total metals analysis, an aliquot from an unfiltered, acid-preserved sample was acid digested using the procedure outlined in Section 11.2 of EPA Method 200.8 and subsequently analyzed. Acid digestion for the total metals analysis facilitates detecting any metals that are not readily soluble in the acidified, unfiltered aliquot. Therefore, the total metals analysis would expectedly yield higher results than the dissolved metals analysis from the same water source. However, this was not the case for the chromium results reported for this sampling event. In fact, the analysis for dissolved chromium produced positive results for every sample, while the total chromium analysis was unable to detect chromium in any sample with the exception AD08856, which showed 3.25 parts per billion (ppb) chromium.

The CAS received samples from a second sampling event from drinking water sources in the Camdenton area on October 19, 2017. During the second sampling, a filter blank sample was collected to determine whether chromium was introduced as a trace contaminant during the sampling process for the dissolved metals. The filter blank sample is laboratory grade, purified

water subjected to identical sampling processes for dissolved metals including filtration. These samples were assigned CAS laboratory numbers AD09219 through AD09235 (17 samples).

The CAS conducted metals analysis on the samples from the second sampling event in the same manner as the first. The chromium data showed similar trends, where trace levels were found in all of the dissolved samples, while no chromium was detected in the total samples, again with the exception of one sample, AD09225, which showed 4.41 ppb chromium. In addition, the filter blank showed no detectible levels of chromium, eliminating the possibility of trace contamination from the sampling process.

Given the questionable nature of the dissolved chromium data from both sampling events, CAS staff researched possible false positive interferences with chromium by EPA Method 200.8 that would be removed by the digestion process for total metals analysis. Their research found that naturally occurring carbonates could produce trace level false positive results for chromium. The interfering carbonates would be removed with the acid digestion process during total metals analysis, but not in the dissolved metals analysis since it is a direct analysis and doesn't include a digestion step. Therefore, it was determined that the undigested dissolved metal samples would be subject to interference from carbonates not present in the total metals samples resulting in elevated dissolved chromium readings. In response to this information, the CAS reanalyzed the dissolved chromium on all of the samples from the two sampling events by an alternative, approved method (EPA 200.7). EPA Method 200.7 utilizes different technology to detect chromium and is unaffected by naturally occurring carbonates.

The resulting data from EPA Method 200.7 revealed no detectable dissolved chromium in any of the samples from both sampling events, confirming the false positive interference from the EPA Method 200.8 results. In response, the CAS invalidated the dissolved chromium results reported by EPA Method 200.8 for samples AD08851 through AD08863 and replaced them with the dissolved chromium results obtained by EPA Method 200.7. Addendum reports were subsequently generated and issued for samples AD08851 through AD08863. The dissolved chromium results for samples AD09219 through AD09235 were reported using the data from EPA Method 200.7.

We apologize for any confusion this situation has caused. Please contact me if you have any questions or further concerns.

KT:tt

APPENDIX C
Chain of Custody
Camdenton Sludge Disposal Area Site
Camdenton, MO

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Description of Delivery
- ☐ Tape sealed and initialed
- ☐ Shipped
- ☒ Hand Delivered

Total No. Of Containers: 16
Carrier:
By:

Collector's Name: (Please Print) Sean Counihan

Affiliation: ☐ KCRO ☐ NERO ☐ SERO ☐ SLRO ☐ SWRO ☐ WPP ☐ MGS ☐ HWP ☒ ESP ☐ MoDOT ☐ MDC ☐ DHSS ☐ Other:

LAB USE ONLY!
Laboratory ID: 171003002 171003003 171003004 171003005
Location: B21

Sample Number	Sample Collected	Analyses Requested	Disinfect. Type	Field Parameters (include units)	Matrix (check one)	Container Type	Preservative Type	Number of Containers
173380 (Sample A) For Lab Use Only AD08850	Date: 9/29/17 ~~10/2/2017~~ Time: 1500	VOC (method 524 N), ~~Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)~~ TT 10/3/17	☒ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O. Flow pH Cond. Temp. Other:	☒ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	~~500mLCN~~ 40mLAG	~~HNO3~~ HCl	~~2~~ 2 TT 10/3/17
173381 (Sample B) For Lab Use Only AD08851	Date: 10/2/2017 Time: 0842	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	☒ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O. Flow pH 7.56 Cond. 535uS Temp. 16.7°C Other:	☒ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500mLCN 40mLAG	HNO3 HCl	2 2
173382 (Sample C) For Lab Use Only AD08852	Date: 10/2/2017 Time: 0915	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	☒ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O. Flow pH 7.04 Cond. 473uS Temp. 17.7°C Other:	☒ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500mLCN 40mLAG	HNO3 HCl	2 2
173383 (Sample D) For Lab Use Only AD08853	Date: 10/2/2017 Time: 0940	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn) TT Per sample vial 10/3/17	☒ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O. Flow pH 7.57 Cond. 496uS Temp. 18.4°C Other:	☒ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500mLCN 40mLAG	HNO3 HCl	2 2

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Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Sample A | **LDPR:** FEPA1 | **Job Code:** NJ00CAMD | **Sample Reference ID:**

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Site | **County:** Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Sample Number: 173380 Trip Blank

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

Sample B | **LDPR:** FEPA1 TT 10/4/17 | **Job Code:** NJØØCAMD | **Sample Reference ID:** Loc. ID 101

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Site | **County:** TT 10/4/17 Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Sample Number: 173381 collected from spigot in front of building

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

Sample C | **LDPR:** FEPA1 TT 10/4/17 | **Job Code:** NJØØCAMD | **Sample Reference ID:** Loc. ID 102

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Site | **County:** 10/4/17 TT Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Sample Number: 173382 collected from spigot off wall of South building

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

Sample D | **LDPR:** FEPA1 TT 10/4/17 | **Job Code:** NJØØCAMD | **Sample Reference ID:** Loc. ID 103

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Site | **County:** TT 10/4/17 Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Sample Number: 173383 collected from spigot in carport

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

Remarks: Please Expedite 15°C

Please print Separately

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Description of Delivery
- [ ] Tape sealed and initialed — Total No. Of Containers: 16
- [ ] Shipped — Carrier:
- [x] Hand Delivered — By:

Collector's Name: Sean Counihan
(Please Print)

Affiliation: [ ] KCRO [ ] NERO [ ] SERO [ ] SLRO [ ] SWRO [ ] WPP [ ] MGS [ ] HWP [x] ESP [ ] MoDOT [ ] MDC [ ] DHSS [ ] Other:

LAB USE ONLY!
Laboratory ID: 1710003006, 1710003007, 1710003008, 1710003009
Location: B21

Sample Number	Sample Collected	Analyses Requested	Disinfect. Type	Field Parameters (include units)	Matrix (check one)	Container Type	Preservative Type	Number of Containers
173384 (Sample A) For Lab Use Only: AD08854	Date: 10/2/2017 Time: 1012	VOC (method 524 N), ~~Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)~~ ok TT 10/3/17	(check one) [x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: Flow: pH: 7.52 Cond.: 475uS Temp.: 16.8°C Other:	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	~~500mLCN~~ 40mLAG @500CN	~~HNO3~~ HCl HNO3	~~2~~ TT OK 2 2 TT 10/3/17
173385 (Sample B) For Lab Use Only: AD08855	Date: 10/2/2017 Time: 1038	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	[x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: Flow: pH: 7.56 Cond.: 445uS Temp.: 16.0°C Other:	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500mLCN 40mLAG	HNO3 HCl	2 2
173386 (Sample C) For Lab Use Only: AD08856	Date: 10/2/2017 Time: 1108	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	[x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: Flow: pH: 7.40 Cond.: 456uS Temp.: 16.5°C Other:	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500mLCN 40mLAG	HNO3 HCl	2 2
173387 (Sample D) For Lab Use Only: AD08857	Date: 10/2/2017 Time: 1135	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	[x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: Flow: pH: 7.43 Cond.: 452uS Temp.: 15.6°C Other:	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500mLCN 40mLAG	HNO3 HCl	2 2

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Relinquished By:	Received By:	Date:	Time:

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Sample A

LDPR:	FEPA1
Job Code:	NJ00CAMD
Sample Reference ID:	Loc ID 104
Facility ID:	
Site/Study Name:	Camdenton Sludge Disposal Site
County:	Camden
Sample Comment (where and how the sample was collected):	☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number:	173384 collected from spigot in front of out building
GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting: / Y Northing: / Accuracy: / (check one) ☐ EPE (meters) ☐ PDOP
Sample Event Type: (check one)	☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project
Sample Type: (check one)	☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply 10/3/17 TT

Sample B

LDPR:	FEPA1 TT 10/4/17
Job Code:	NJØØCAMD
Sample Reference ID:	Loc. ID 105
Facility ID:	
Site/Study Name:	Camdenton Sludge Disposal Site
County:	10/4/17 TT Camden
Sample Comment (where and how the sample was collected):	☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number:	173385 collected from spigot along driveway
GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting: / Y Northing: / Accuracy: / (check one) ☐ EPE (meters) ☐ PDOP
Sample Event Type: (check one)	☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project
Sample Type: (check one)	☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

Sample C

LDPR:	FEPA1 TT 10/4/17
Job Code:	NJØØCAMD
Sample Reference ID:	Loc ID 06
Facility ID:	
Site/Study Name:	Camdenton Sludge Disposal Site
County:	TT 10/4/17 Camden
Sample Comment (where and how the sample was collected):	☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number:	173386 collected from spigot off City Well piping emergency drinking water well
GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting: / Y Northing: / Accuracy: / (check one) ☐ EPE (meters) ☐ PDOP
Sample Event Type: (check one)	☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project
Sample Type: (check one)	☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

Sample D

LDPR:	FEPA1 10/4/17 TT
Job Code:	NJØØCAMD
Sample Reference ID:	Loc ID 107
Facility ID:	X
Site/Study Name:	Camdenton Sludge Disposal Site
County:	10/4/17 TT Camden
Sample Comment (where and how the sample was collected):	☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number:	173387 collected from spigot off well house in front yard
GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting: / Y Northing: / Accuracy: / (check one) ☐ EPE (meters) ☐ PDOP
Sample Event Type: (check one)	☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project
Sample Type: (check one)	☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply 10/3/17 TT

Remarks: Please Expedite

Please Print Separately

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MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Description of Delivery
- ☐ Tape sealed and initialed — Total No. Of Containers: 10
- ☐ Shipped — Carrier:
- ☐ Hand Delivered — By:

Collector's Name: (Please Print) Sean Counihan

Affiliation: ☐ KCRO ☐ NERO ☐ SERO ☐ SLRO ☐ SWRO ☐ WPP ☐ MGS ☐ HWP ☒ ESP ☐ MoDOT ☐ MDC ☐ DHSS ☐ Other:

LAB USE ONLY!
Laboratory ID: 171003010 171003011 171003012 171003013
Location: B21

Sample Number	Sample Collected	Analyses Requested	Disinfect. Type (check one)	Field Parameters (include units)	Matrix (check one)	Container Type	Preservative Type	Number of Containers
173388 (Sample A) For Lab Use Only: AD08858	Date: 10/2/2017 Time: 1200	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	☒ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O.: Flow: pH: 7.60 Cond.: ~~420uS~~ 420uS Temp.: ~~15.6~~ 16.1°C Other:	☒ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500mL CN 40mL AG	HNO3 HCl	2 2
173389 (Sample B) For Lab Use Only: AD08859	Date: 10/2/2017 Time: 1222	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	☒ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O.: Flow: pH: 7.45 Cond.: 525uS Temp.: 16.1°C Other:	☒ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500mL CN 40mL AG	HNO3 HCl	2 2
173390 (Sample C) For Lab Use Only: AD08860	Date: 10/2/2017 Time: 0000	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	☒ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O.: Flow: pH: Cond.: Temp.: Other:	☒ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500mL CN 40mL AG	HNO3 HCl	2 2
173391 (Sample D) For Lab Use Only: AD08861	Date: 10/2/2017 Time: 1250	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	☒ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O.: Flow: pH: 7.47 Cond.: 544uS Temp.: 16.0°C Other:	☒ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500mL CN 40mL AG	HNO3 HCl	2 2

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MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Sample A | **LDPR:** FEPA1 | **Job Code:** NJ00CAMD | **Sample Reference ID:** Loc. ID 108

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Site | **County:** Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number: 173388 collected from spigot on back of house

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample B | **LDPR:** FEPA1 TT 10/4/17 | **Job Code:** NJØØCAMD | **Sample Reference ID:** Loc ID 109

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Site | **County:** TT 10/4/17 Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number: 173389 collected from spigot of stonewell house

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample C | **LDPR:** FEPA1 TT 10/4/17 | **Job Code:** NJØØCAMD | **Sample Reference ID:**

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Site | **County:** TT 10/4/17 Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number: 173390 Blind Duplicate

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample D | **LDPR:** FEPA1 TT 10/4/17 | **Job Code:** NJ0ØCAMD | **Sample Reference ID:** Loc. ID 110

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Site | **County:** 10/4/17 TT Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number: 173391 Collected from spigot near horse trough

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Remarks: Please Expedite 15°C
Please print Separately

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Description of Delivery

- ☐ Tape sealed and initialed — Total No. Of Containers: 8
- ☐ Shipped — Carrier:
- ☐ Hand Delivered — By:

Collector's Name: (Please Print) Sean Counihan

Affiliation: ☐ KCRO ☐ NERO ☐ SERO ☐ SLRO ☐ SWRO ☐ WPP ☐ MGS ☐ HWP ☐ ESP ☐ MoDOT ☐ MDC ☐ DHSS ☐ Other:

LAB USE ONLY!

Laboratory ID: 171003014, 171003015

Location: 821

Sample Number	Sample Collected	Analyses Requested	Disinfect. Type	Field Parameters (include units)	Matrix (check one)	Container Type	Preservative Type	Number of Containers
172314 (Sample A) For Lab Use Only: AD08862	Date: 10/2/2017 Time: 1330	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	(check one) ☒ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O.: Flow: pH: 7.58 Cond.: 475us Temp.: 16.3°C Other:	☒ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500mL CN; 40mL AG	HNO3; HCl	2; 2
172315 (Sample B) For Lab Use Only: AD08863	Date: 10/2/2017 Time: 1355	VOC (method 524 N), Total and Dissolved Metals (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	☒ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O.: Flow: pH: 7.78 Cond.: 507us Temp.: 17.6°C Other:	☒ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500mL CN; 40mL AG	HNO3; HCl	2; 2
(Sample C) For Lab Use Only	Date: ~~10/2/2017~~ Time:	VOC (method 524 N) Total and Dissolved Metals (As, Ba, Cd, ~~Cr, Cu, Se, Pb, Zn)~~	☐ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O. Flow pH Cond. Temp. Other:	☐ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:			
(Sample D) For Lab Use Only	Date: ~~10/2/2017~~ Time:	~~VOC (method 524 N) Total and Dissolved Metals~~ (As, Ba, Cd, Cr, Cu, Se, Pb, Zn)	☐ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O. Flow pH Cond. Temp. Other:	☐ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:			

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MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Sample A | **LDPR:** FEPA1 | **Job Code:** NJ00CAMD | **Sample Reference ID:** Loc. ID 111

Facility ID:
Site/Study Name: Camdenton Sludge Disposal Site
County: Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number: 172314 collected from spigot off well house

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

Sample B | **LDPR:** FEPA1 TT 10/4/17 | **Job Code:** NJØØCAMD | **Sample Reference ID:** Loc ID 112

Facility ID:
Site/Study Name: Camdenton Sludge Disposal Site
County: TT 10/4/17 Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number: 172315 Collected from spigot near well head

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ~~☑ Groundwater~~ ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply TT 10/3/17

Sample C | **LDPR:** FEPA1 TT 10/4/17 | **Job Code:** NJØØCAMD | **Sample Reference ID:**

Facility ID:
Site/Study Name: Camdenton Sludge Disposal Site
County: TT 10/4/17 Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number:

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☑ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☐ Drinking Water Supply

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Sample D | **LDPR:** FEPA1 TT | **Job Code:** NJØØCAMD | **Sample Reference ID:**

Facility ID:
Site/Study Name: 10/4/17 Camdenton Sludge Disposal Site
County: TT 10/4/17 Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:
Sample Number:

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☑ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☐ Drinking Water Supply

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Remarks: Please Expedite 15°°
please print Separately

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Description of Delivery

- [ ] Tape sealed and initialed — Total No. Of Containers: 10
- [ ] Shipped — Carrier:
- [x] Hand Delivered — By:

Collector's Name: Kenneth Hannon
(Please Print)

Affiliation: [ ] KCRO [ ] NERO [ ] SERO [ ] SLRO [ ] SWRO [ ] WPP [ ] MGS [ ] HWP [x] ESP [ ] MoDOT [ ] MDC [ ] DHSS [ ] Other:

LAB USE ONLY! Laboratory ID: 171020003 Location: B26

Sample Number	Sample Collected	Analyses Requested	Disinfect. Type (check one)	Field Parameters (include units)	Matrix (check one)	Container Type	Preservative Type	Number of Containers
173977 (Sample A) For Lab Use Only: AD09219	Date: 10/19/17 Time: 810	(KH) ~~Hexavalent Cr, total and~~ dissolved (Cr, As, Ba, Cd, Cu, Pb, Se, and Zn).	[x] None	D.O.: ; Flow: ; pH: ~~7.24~~ (KH); Cond.: ~~469.1~~; Temp.: ~~16.7~~; Other: ; ORP ~~133.7~~	[x] Water	500 CN ~~250 CN~~	HNO3 ~~am. Sulfate am Hydroxide~~	1 ~~+ 1~~
173978 (Sample B) For Lab Use Only: AD09220	Date: 10/19/17 Time: 0825	~~Hexavalent Cr~~, total and dissolved (Cr, As, Ba, Cd, Cu, Pb, Se, and Zn).	[x] None	D.O.: ; Flow: ; pH: 7.24; Cond.: 469.1 us; Temp.: 16.7 °c; Other: ; ORP 133.7 mV	[x] Water	500 CN	HNO3	2
173979 (Sample C) For Lab Use Only: AD09221	Date: 10/19/17 Time: 0852	(KH) ~~Hexavalent Cr~~, total and dissolved (Cr, As, Ba, Cd, Cu, Pb, Se, and Zn). Hexavalent Cr.	[x] None	D.O.: ; Flow: ; pH: 7.16; Cond.: 461.5 µS; Temp.: 14.6 °c; Other: ; ORP 144.4 mV	[x] Water	500 CN 250 CN	HNO3 am. Hy. am. Sulfed	2 1
173980 (Sample D) For Lab Use Only: AD09222	Date: 10/19/17 Time: —	(KH) ~~Hexavalent Cr~~, total and dissolved (Cr, As, Ba, Cd, Cu, Pb, Se, and Zn). Hexavalent Cr.	[x] None	D.O.: ; Flow: ; pH: ; Cond.: ; Temp.: ; Other:	[x] Water	500 CN 250 CN	HNO3 am. Hydroxide am. Sulfat	2 1

Relinquished By:	Received By:	Date:	Time:
Kenneth Hannon	[signature]	10/20/17	1007

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Sample A

Sample A	LDPR: FEPA1	Job Code: NJ00CAMD	Sample Reference ID:
Facility ID:	Site/Study Name: Camdenton Sludge Disposal Area	County: Camden	

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Filter Blank.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☒ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☐ Drinking Water Supply

Sample B

Sample B	LDPR: FEPA1	Job Code: NJ00CAMD	Sample Reference ID:
Facility ID:	Site/Study Name: Camdenton Sludge Disposal Area	County: Camden	

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID #111, inside house kitchen sink faucet. #173978.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Sample C

Sample C	LDPR: FEPA1	Job Code: NJ00CAMD	Sample Reference ID:
Facility ID:	Site/Study Name: Camdenton Sludge Disposal Area	County: Camden	

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID 111, ~~first~~ outside house near well head. #173977

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Sample D

Sample D	LDPR: FEPA1	Job Code: NJ00CAMD	Sample Reference ID:
Facility ID:	Site/Study Name: Camdenton Sludge Disposal Area	County: Camden	

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Blind Duplicate. #173980.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Remarks: Print results separately. Expedite samples + hold hex Cr pending results

1.8 C

MISSOURI DEPARTMENT OF NATURAL RESOURCES FIELD SHEET AND CHAIN-OF-CUSTODY RECORD	Description of Delivery
	[ ] Tape sealed and initialed — Total No. Of Containers: 12 [ ] Shipped — Carrier: [x] Hand Delivered — By:

Collector's Name: (Please Print) Kenneth Hannon

Affiliation: [ ] KCRO [ ] NERO [ ] SERO [ ] SLRO [ ] SWRO [ ] WPP [ ] MGS [ ] HWP [x] ESP [ ] MoDOT [ ] MDC [ ] DHSS [ ] Other:

LAB USE ONLY! Laboratory ID: 1710Q0003 — Location: B26

Sample Number	Sample Collected	Analyses Requested	Disinfect. Type (check one)	Field Parameters (include units)	Matrix (check one)	Container Type	Preservative Type	Number of Containers
173981 (Sample A) For Lab Use Only: AD09223	Date: 10/19/17 Time: 0922 ~~0944~~ KH	Hexavalent Cr, total and dissolved (Cr and Zn)	[x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: Flow: pH: 7.29 Cond.: 449.9 us Temp.: 14.7 °C Other: ORP: 103.7 mV	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500 CW 250 CW	HNO3 am. sulfate am. hydroxide	2 1
173982 (Sample B) For Lab Use Only: AD09224	Date: 10/19/17 Time: 0944	Hexavalent Cr, total and dissolved Cr and Zn	[x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: Flow: pH: 7.55 Cond.: 455.4 us Temp.: 16.7 °C Other: ORP: 103.7 mV	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500 CW 250 CW	HNO3 NH3OH $(NH_4)_2SO_4$	2 1
173983 (Sample C) For Lab Use Only: AD09225	Date: 10/19/17 Time: 1009	Hexavalent Cr, total and dissolved Cr and Zn.	[x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: Flow: pH: 7.53 Cond.: 454.0 us Temp.: 15.7 °C Other: ORP: 64.6 mV	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500 CW 250 CW	HNO3 NH3OH $(NH_4)_2SO_4$	2 1
173984 (Sample D) For Lab Use Only: AD09226	Date: 10/19/17 Time: 1040	Hexavalent Cr, total and dissolved Cr and Zn.	[x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: Flow: pH: 7.42 Cond.: 506.3 us Temp.: 15.4 °C Other: ORP: 84.0 mV	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500 CW 250 CW	HNO3 NH3OH $(NH_4)_2SO_4$	3

Relinquished By:	Received By:	Date:	Time:
Kenneth Hannon	[signature]	10/20/17	1007

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Sample A	LDPR: FEPA1	Job Code: NJ00CAMD	Sample Reference ID:
Facility ID:	Site/Study Name: Camdenton Sludge Disposal Area	County: Camden	

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc. ID 112 spigot nearest well head. #173981.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one) ☐ EPE (meters) ☐ PDOP

Sample Event Type: (check one) ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: (check one) ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Sample B	LDPR: FEPA1	Job Code: NJ00CAMD	Sample Reference ID:
Facility ID:	Site/Study Name: Camdenton Sludge Disposal Area	County: Camden	

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID 103 spigot in the front of the house. #173982.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one) ☐ EPE (meters) ☐ PDOP

Sample Event Type: (check one) ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: (check one) ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Sample C	LDPR: FEPA1	Job Code: NJ00CAMD	Sample Reference ID:
Facility ID:	Site/Study Name: Camdenton Sludge Disposal Area	County: Camden	

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID 106 PWSD #2 well spigot on well head. #173983.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one) ☐ EPE (meters) ☐ PDOP

Sample Event Type: (check one) ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: (check one) ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Sample D	LDPR: FEPA1	Job Code: NJ00CAMD	Sample Reference ID:
Facility ID:	Site/Study Name: Camdenton Sludge Disposal Area	County: Camden	

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID 101, spigot in front of building #173984.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one) ☐ EPE (meters) ☐ PDOP

Sample Event Type: (check one) ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: (check one) ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Remarks:
Print results separately. Expedite samples + hold hex Cr. pending results

IC

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Description of Delivery
- [ ] Tape sealed and initialed
- [ ] Shipped
- [x] Hand Delivered

Total No. Of Containers: 12
Carrier:
By:

Collector's Name: (Please Print) Kenneth Hannon

Affiliation: [ ] KCRO [ ] NERO [ ] SERO [ ] SLRO [ ] SWRO [ ] WPP [ ] MGS [ ] HWP [x] ESP [ ] MoDOT [ ] MDC [ ] DHSS [ ] Other:

LAB USE ONLY!
Laboratory ID: 171020003
Location: B26

Sample Number	Sample Collected	Analyses Requested	Disinfect. Type	Field Parameters (include units)	Matrix (check one)	Container Type	Preservative Type	Number of Containers
173985 (Sample A); For Lab Use Only: AD09227	Date: 10/19/17; Time: 1100	Hexavalent Cr, total and dissolved Cr and Zn	[x] None	D.O.: ; Flow: ; pH: 7.50; Cond.: 514.6 us; Temp.: 14.8°C; Other: ; ORP: 41.4 mV	[x] Water	500CN; 250CN	HNO3; NH3OH; (NH4)2SO4	2; 1
173986 (Sample B); For Lab Use Only: AD09228	Date: 10/19/17; Time: 1140	Hexavalent Cr, total and dissolved Cr and Zn	[x] None	D.O.: ; Flow: ; pH: 7.49; Cond.: 534.5 us; Temp.: 15.0°C; Other: ; ORP: 80.0 mV	[x] Water	500CN; 250CN	HNO3; NH3OH; (NH4)2SO4	2; 1
173987 (Sample C); For Lab Use Only: AD09229	Date: 10/19/17; Time: 1205	Hexavalent Cr, total and dissolved Cr and Zn	[x] None	D.O.: ; Flow: ; pH: 7.48; Cond.: 462.1 us; Temp.: 16.1°C; Other: ; ORP: 33.7 mV	[x] Water	500CN; 250CN	HNO3; NH3OH; (NH4)2SO4	2; 1
173988 (Sample D); For Lab Use Only: AD09230	Date: 10/19/17; Time: 1334	Hexavalent Cr, total and dissolved Cr and Zn, Pb, As, Ba, Cu, Se, Cd	[x] None	D.O.: ; Flow: ; pH: 7.43; Cond.: 575 us; Temp.: 15.6°C; Other: ; ORP: 187.3 mV	[x] Water	500CN; 250CN	HNO3; NH3OH; (NH4)2SO4	2; 1

Disinfect. Type options: None, Chlorine, UV, Ozone, Other. Matrix options: Water, Soil, Organic, Sludge, Other.

Relinquished By	Received By	Date	Time
Kenneth Hannon	[signature]	10/20/17	1007

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Sample A | **LDPR:** FEPA1 | **Job Code:** NJ00CAMD | **Sample Reference ID:**

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Area | **County:** Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID ~~173985~~ 109 well head spigot. #173985.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one) ☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Sample B | **LDPR:** FEPA1 | **Job Code:** NJ00CAMD | **Sample Reference ID:**

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Area | **County:** Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID 110 spigot on the front of the house next to well head #173986.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one) ☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Sample C | **LDPR:** FEPA1 | **Job Code:** NJ00CAMD | **Sample Reference ID:**

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Area | **County:** Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID 104 spigot near work shed. #173987.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one) ☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Sample D | **LDPR:** FEPA1 | **Job Code:** NJ00CAMD | **Sample Reference ID:**

Facility ID: | **Site/Study Name:** Camdenton Sludge Disposal Area | **County:** Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID 123 spigot in front of the house. #173988

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one) ☐ EPE (meters) ☐ PDOP

Sample Event Type: *(check one)* ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: *(check one)* ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Remarks: Print results separately. Exedite samples + hold hex. Cr. pending results

1C

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Description of Delivery

- ☐ Tape sealed and initialed
- ☐ Shipped
- ☑ Hand Delivered

Total No. Of Containers: 8 12
Carrier:
By:

Collector's Name: (Please Print) Kenneth Hannon

Affiliation: ☐ KCRO ☐ MoDOT ☐ NERO ☐ MDC ☐ SERO ☐ DHSS ☐ SLRO ☐ Other: ☐ SWRO ☐ WPP ☐ MGS ☐ HWP ☑ ESP

LAB USE ONLY!
Laboratory ID: 171020003
Location: 326

Sample Number	Sample Collected	Analyses Requested	Disinfect. Type (check one)	Field Parameters (include units)		Matrix (check one)	Container Type	Preservative Type	Number of Containers
173989 (Sample A)	Date: 10/19/17	Hexavalent Cr, total and dissolved (Cr, As, Cd, Cu, Ba, Pb, Se and Zn).	☑ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O.: Flow: pH: 7.09 Cond.: 703 us Temp.: 15.5 °C Other: ORP: 118.2 mV		☑ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500CW 250CW	HNO3 NH3OH $(NH_4)_2SO_4$	2 1
For Lab Use Only: AD09231	Time: 1400								
173990 (Sample B)	Date: 10/19/17	Hexavalent Cr, total and dissolved Cr and Zn.	☑ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O.: Flow: pH: 7.56 Cond.: 427.8 us Temp.: 17.0 °C Other: ORP: 91.7 mV		☑ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500CW 250CW	HNO3 NH3OH $(NH_4)_2SO_4$	2 1
For Lab Use Only: AD09232	Time: 1440								
173991 (Sample C)	Date: 10/19/17	Hexavalent Cr, total and dissolved Cr and Zn.	☑ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O.: Flow: pH: 7.45 Cond.: 460.1 us Temp.: 15.2 °C Other: ORP: 73.4 mV		☑ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500CW 250CW	HNO3 NH3OH $(NH_4)_2SO_4$	2 1
For Lab Use Only: AD09233	Time: 1500								
173992 (Sample D)	Date: 10/19/17	Hexavalent Cr, total and dissolved Cr and Zn.	☑ None ☐ Chlorine ☐ UV ☐ Ozone ☐ Other:	D.O.: Flow: pH: 7.36 Cond.: 438.6 us Temp.: 15.2 °C Other: ORP: 98.2 mV		☑ Water ☐ Soil ☐ Organic ☐ Sludge ☐ Other:	500CW 250CW	HNO3 NH3OH $(NH_4)_2SO_4$	2 1
For Lab Use Only: AD09234	Time: 1522								

Relinquished By:	Received By:	Date:	Time:
Kenneth Hannon	[signature]	10/20/17	1007
Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Sample A | LDPR: FEPA1 | Job Code: NJ00CAMD | Sample Reference ID:

Facility ID: | Site/Study Name: Camdenton Sludge Disposal Area | County: Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID #18 spigot on the side of the house. #173989

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: (check one) ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: (check one) ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Sample B | LDPR: FEPA1 | Job Code: NJ00CAMD | Sample Reference ID:

Facility ID: | Site/Study Name: Camdenton Sludge Disposal Area | County: Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID 102 spigot in front of building. #173990

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: (check one) ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: (check one) ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Sample C | LDPR: FEPA1 | Job Code: NJ00CAMD | Sample Reference ID:

Facility ID: | Site/Study Name: Camdenton Sludge Disposal Area | County: Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID 105 spigot next to well head. #173991

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: (check one) ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: (check one) ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Sample D | LDPR: FEPA1 | Job Code: NJ00CAMD | Sample Reference ID:

Facility ID: | Site/Study Name: Camdenton Sludge Disposal Area | County: Camden

Sample Comment (where and how the sample was collected): ☑ Grab ☐ Composite ☐ Modified ☐ Other:

Loc ID 107 spigot on well house. #173992.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				☐ EPE (meters) ☐ PDOP

Sample Event Type: (check one) ☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project

Sample Type: (check one) ☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☒ Drinking Water Supply

Remarks: Print results separately. Expedite samples and hold hex.Cr. pending results   1C

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Description of Delivery

- [ ] Tape sealed and initialed — Total No. Of Containers: 3
- [ ] Shipped — Carrier:
- [ ] Hand Delivered — By:

Collector's Name: (Please Print) Kenneth Hannon

Affiliation: [ ] KCRO [ ] NERO [ ] SERO [ ] SLRO [ ] SWRO [ ] WPP [ ] MGS [ ] HWP [ ] ESP [ ] MoDOT [ ] MDC [ ] DHSS [ ] Other:

LAB USE ONLY! Laboratory ID: ~~1780~~ 171020003 — Location: B26

Sample Number	Sample Collected	Analyses Requested	Disinfect. Type (check one)	Field Parameters (include units)		Matrix (check one)	Container Type	Preservative Type	Number of Containers
173993 (Sample A)	Date: 10/19/17	Hexavalent Cr total and dissolved Cr and Zn	[ ] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O. Flow pH Cond. Temp. Other: ORP	 7.52 413.9 us 15.1 °C 84.0 mV	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500cN 250cN	HNO3 NH3OH (NH4)2SO4	2 1
For Lab Use Only: AD09235	Time: 1545								
(Sample B)	Date:		[ ] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O. Flow pH Cond. Temp. Other:		[ ] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:			
For Lab Use Only	Time:								
(Sample C)	Date:		[ ] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O. Flow pH Cond. Temp. Other:		[ ] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:			
For Lab Use Only	Time:								
(Sample D)	Date:		[ ] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O. Flow pH Cond. Temp. Other:		[ ] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:			
For Lab Use Only	Time:								

Relinquished By	Received By	Date	Time
Relinquished By: Kenneth Hannon	Received By: [signature]	Date: 10/20/17	Time: 1007
Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Sample A | LDPR: FEPA1 | Job Code: NJ00CAMD | Sample Reference ID:

Facility ID: | Site/Study Name: Camdenton Sludge Area | County: Camden

Sample Comment (where and how the sample was collected): [X] Grab [ ] Composite [ ] Modified [ ] Other:

Loc ID 108 spigot on the back of the house. # 173993.

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				[ ] EPE (meters) [ ] PDOP

Sample Event Type: (check one)
[ ] Bypass/SSO [ ] Complaint [ ] Emergency Response [ ] Inspection [X] Investigation [ ] Monitoring [ ] Special Project

Sample Type: (check one)
[ ] Air [ ] Soil [ ] Container [ ] Spill [ ] QA/QC [ ] Wipes [ ] Groundwater [ ] Storm Water [ ] Organic [ ] Surface Water [ ] Sediment [ ] Discharge [ ] Sludge [X] Drinking Water Supply

Sample B | LDPR: | Job Code: | Sample Reference ID:

Facility ID: | Site/Study Name: | County:

Sample Comment (where and how the sample was collected): [ ] Grab [ ] Composite [ ] Modified [ ] Other:

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				[ ] EPE (meters) [ ] PDOP

Sample Event Type: (check one)
[ ] Bypass/SSO [ ] Complaint [ ] Emergency Response [ ] Inspection [ ] Investigation [ ] Monitoring [ ] Special Project

Sample Type: (check one)
[ ] Air [ ] Soil [ ] Container [ ] Spill [ ] QA/QC [ ] Wipes [ ] Groundwater [ ] Storm Water [ ] Organic [ ] Surface Water [ ] Sediment [ ] Discharge [ ] Sludge [ ] Drinking Water Supply

Sample C | LDPR: | Job Code: | Sample Reference ID:

Facility ID: | Site/Study Name: | County:

Sample Comment (where and how the sample was collected): [ ] Grab [ ] Composite [ ] Modified [ ] Other:

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				[ ] EPE (meters) [ ] PDOP

Sample Event Type: (check one)
[ ] Bypass/SSO [ ] Complaint [ ] Emergency Response [ ] Inspection [ ] Investigation [ ] Monitoring [ ] Special Project

Sample Type: (check one)
[ ] Air [ ] Soil [ ] Container [ ] Spill [ ] QA/QC [ ] Wipes [ ] Groundwater [ ] Storm Water [ ] Organic [ ] Surface Water [ ] Sediment [ ] Discharge [ ] Sludge [ ] Drinking Water Supply

Sample D | LDPR: | Job Code: | Sample Reference ID:

Facility ID: | Site/Study Name: | County:

Sample Comment (where and how the sample was collected): [ ] Grab [ ] Composite [ ] Modified [ ] Other:

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	(check one)
				[ ] EPE (meters) [ ] PDOP

Sample Event Type: (check one)
[ ] Bypass/SSO [ ] Complaint [ ] Emergency Response [ ] Inspection [ ] Investigation [ ] Monitoring [ ] Special Project

Sample Type: (check one)
[ ] Air [ ] Soil [ ] Container [ ] Spill [ ] QA/QC [ ] Wipes [ ] Groundwater [ ] Storm Water [ ] Organic [ ] Surface Water [ ] Sediment [ ] Discharge [ ] Sludge [ ] Drinking Water Supply

Remarks: Print results separately, Expedite samples and hold hex. Cr. pending results.

1 C

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Description of Delivery
- [ ] Tape sealed and initialed — Total No. Of Containers: 4
- [ ] Shipped — Carrier:
- [x] Hand Delivered — By:

Collector's Name: (Please Print) Sean Counihan

Affiliation: [ ] KCRO [ ] MoDOT [ ] NERO [ ] MDC [ ] SERO [ ] DHSS [ ] SLRO [ ] Other: [ ] SWRO [ ] WPP [ ] MGS [ ] HWP [x] ESP

LAB USE ONLY! Laboratory ID: 180214003 Location: C1

Sample Number	Sample Collected	Analyses Requested	Disinfect. Type (check one)	Field Parameters (include units)	Matrix (check one)	Container Type	Preservative Type	Number of Containers
181072 (Sample A) For Lab Use Only: AD15265	Date: 2/13/2018 Time: 1233	Total Metals (Pb)	[x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: ; Flow: ; pH: 7.53; Cond.: 577µs; Temp.: 12.7°C; Other:	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500mLCN	HNO3	1
181073 (Sample B) For Lab Use Only: AD15266	Date: 2/13/2018 Time: 1246	Total Metals (Pb)	[x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: ; Flow: ; pH: 7.35; Cond.: 551µs; Temp.: 12.1°C; Other:	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500mLCN	HNO3	1
181074 (Sample C) For Lab Use Only: AD15267	Date: 2/13/2018 Time: 1249	Total Metals (Pb)	[x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: ; Flow: ; pH: 7.46; Cond.: 560µs; Temp.: 13.7°C; Other:	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500mLCN	HNO3	1
181075 (Sample D) For Lab Use Only: AD15268	Date: 2/13/2018 Time: 1252	Total Metals (Pb)	[x] None [ ] Chlorine [ ] UV [ ] Ozone [ ] Other:	D.O.: ; Flow: ; pH: ; Cond.: ; Temp.: ; Other:	[x] Water [ ] Soil [ ] Organic [ ] Sludge [ ] Other:	500mLCN	HNO3	1

Relinquished By:	Received By:	Date:	Time:
[signature]	[signature]	2/14/18	0810

MISSOURI DEPARTMENT OF NATURAL RESOURCES
FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

Sample A | **LDPR:** FEPA1 | **Job Code:** NJ00CAMD | **Sample Reference ID:** Location ID 123

Facility ID:	
Site/Study Name:	Camdenton Sludge Disposal Site
County:	Camden
Sample Comment (where and how the sample was collected):	☑ Grab ☐ Composite ☐ Modified ☐ Other:
	Sample # 181072 - Sample collected from spigot on front of house
Sample Event Type: *(check one)*	☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project
Sample Type: *(check one)*	☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	*(check one)*
				☐ EPE (meters) ☐ PDOP

Sample B | **LDPR:** FEPA1 | **Job Code:** NJ00CAMD | **Sample Reference ID:** Location ID 123

Facility ID:	
Site/Study Name:	Camdenton Sludge Disposal Site
County:	Camden
Sample Comment (where and how the sample was collected):	☑ Grab ☐ Composite ☐ Modified ☐ Other:
	Sample # 181073 - Sample collected from kitchen sink tap
Sample Event Type: *(check one)*	☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project
Sample Type: *(check one)*	☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	*(check one)*
				☐ EPE (meters) ☐ PDOP

Sample C | **LDPR:** FEPA1 | **Job Code:** NJ00CAMD | **Sample Reference ID:** Location ID 123

Facility ID:	
Site/Study Name:	Camdenton Sludge Disposal Site
County:	Camden
Sample Comment (where and how the sample was collected):	☑ Grab ☐ Composite ☐ Modified ☐ Other:
	Sample # 181074 - Sample collected from filtered refrigerator water dispenser
Sample Event Type: *(check one)*	☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project
Sample Type: *(check one)*	☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	*(check one)*
				☐ EPE (meters) ☐ PDOP

Sample D | **LDPR:** FEPA1 | **Job Code:** NJ00CAMD | **Sample Reference ID:** Location ID 123

Facility ID:	
Site/Study Name:	Camdenton Sludge Disposal Site
County:	Camden
Sample Comment (where and how the sample was collected):	☑ Grab ☐ Composite ☐ Modified ☐ Other:
	Sample # 181075 - collected from a Brita water filtration pitcher system
Sample Event Type: *(check one)*	☐ Bypass/SSO ☐ Complaint ☐ Emergency Response ☐ Inspection ☑ Investigation ☐ Monitoring ☐ Special Project
Sample Type: *(check one)*	☐ Air ☐ Soil ☐ Container ☐ Spill ☐ QA/QC ☐ Wipes ☐ Groundwater ☐ Storm Water ☐ Organic ☐ Surface Water ☐ Sediment ☐ Discharge ☐ Sludge ☑ Drinking Water Supply

GPS Coordinates (UTM Zone 15 NAD83 Only)	X Easting	Y Northing	Accuracy	*(check one)*
				☐ EPE (meters) ☐ PDOP

Remarks: 0°C

APPENDIX D

Field Notes

Camdenton Sludge Disposal Area Site

Camdenton, MO

Camdenton Sludge site
10/2/17
water quality check
extech pen
pH @ 4 = 4.01
pH @ 7 = 6.99
Cond @ 1413 = 1417

Trip Blank collected @ 1500 on
9/29/30 Sample # 173380

~~Property~~ Location ID 101 1056 old S. 5 Hwy
Spigot in front of building
Started Purge at 0830
High Flow

1st reading 0835
Temp = 17.3°C
Cond = 620 uS
pH = 7.58

2nd reading at 0838
Temp = 16.6°C
Cond = 560 uS
pH ~ 7.58

3rd reading @ 0841
Temp = 16.7°C
Cond = 535 uS
pH = 7.56
Sample collected at 0842
Sample # 173381

Location ID 102
1629 old S. 5 Hwy
Spigot out of South building wall
Started purge at 0904
High Flow

1st Reading at 0909
Temp 18.1°C
Cond 488 uS
pH 7.66

2nd reading at 0912
Temp = 17.7°C
Cond = 473 uS
pH = 7.64
Sample collected at 0915
Sample # 173382

Location ID 103
1951 Old S. Hwy 5
Spigot in ~~garage~~/carport
Started Purge at 0929
High flow for purge

1st reading at 0934
Temp = 19.1°c
Cond = 502 us
pH = 7.59

2nd reading at ~~0934~~ 0937
Temp = 18.4°c
Cond = 496 us
pH = 7.59
Sample collected at 0940
Sample # 173383

Location ID 104
1941 S. Old Hwy 5
Started purge at 1002 from
Spigot in front of out building

1st reading at 1007
Temp = 17.2°c
Cond = 461 us
pH = 7.56

2nd reading at 1010
Temp = 16.8°c
Cond = 475 us
pH = 7.52
Sample collected at 1012
Sample # 173384

Location ID 105
183 St. Nicholas
Spigot along driveway
Started purge at 1028
1st reading at 1033
Temp = 17.0°c
Cond = 442 us
pH = 7.59
2nd reading at 1036
Temp 16.0°C
Cond 445 us
pH 7.56
Sample collected at 1038
Sample # 173385

10/2/17 Camdenton Sludge Site

Location ID 106

Back up city well
at Camdenton Air Port
~~Has~~ Doesn't run regularly last
run sometime last week
Turned on at 1052 runs
90 gallons/min
Let Run for 10 min to purge
well -
Ran sampling purge check after that

1st reading at 1102
Temp 17.3°C
Cond 460 uS
pH = 7.64
2nd reading at 1105
Temp 16.5°C
Cond 456 uS
pH = 7.60
Sample collected at 1108
Sample # 173386

Location ID 107
250 Sunflower
Started purge at 1125
1st Reading ~~at~~ 1130
Temp = 16.4°C
Cond = 450 uS
pH = 7.43
2nd Reading at 1133
Temp = 15.6°C
Cond = 452 uS
pH = 7.43
Sample collected at 1135
Sample # 173387
Spigot off well house in front yard

Location 108
190 Sunflower
Started Purge at 1147
~~1st~~ Spigot on back of House
1st reading at 1152
Temp = 15.6°C
Cond = 418 uS
pH = 7.63
2nd reading at 1155
Temp = 16.1
Cond = 420
pH = 7.60

Sample collected @ 1200
Sample # 173388

Location ID 109
611 Forbes RD
Started Purge at 1212 spigot at Stone wellhouse
1st reading at 1217
Temp 16.5°C
Cond 538us
pH = 7.65
2nd reading at 1220
Temp = 16.1°C
Cond = 535us
pH = 7.65
Sample collected at 1222
Sample # 173389

Blind Duplicate collected here
Sample # 173390

Location ID 110
602 Forbes Road
Started purge at 1240
from spigot over horse trough
1st reading at 1245
Temp = 16.9°C
Cond = 538us
pH = 7.42

2nd reading at 1248
Temp = 16.0°C
Cond = 544us
pH = 7.47
Sample collected at 1250
Sample # 173391

Location ID 111
193 Forbes
Collected from spigot off well house
Started purge at 1320
1st reading at 1325
Temp = 16.4°C
Cond = 491us
pH = 7.52
2nd reading at 1328
Temp = 16.3°C
Cond = 475
pH = 7.58
Sample collected at 1330
Sample # 172314

Location ID 112
88 Forbes Road
began purge at 1346
from spigot near well head
1st reading at 1351
Temp = 18.1°C
Cond = 524 uS
pH = 7.72
2nd reading at 1354
Temp = 17.6°C
Cond = 507 uS
pH = 7.78
Sample collected at 1355
Sample # 172315

Camdenton Sludge Disposal
EEPA1/NJ00CAMD

Date: 10/19/17
Arrival Time: 0800
Depart Time:

Participants: Eric Sappington
Keith Brown

Conditions: Sunny ≈ 54°F

Calibrations

		Act.	Read	
YSI Pro	pH	7.0	7.03	ok
		4.0	4.07	ok
	Cond.	1413	1400	ok
	ORP	200	188.6	ok

Loc 111 | Inside house

pH	6.86	7.14	7.25	7.24
Temp	~~476.4~~ 17.4	17.3	17.1	16.7
Cond	476.4	470	471.5	469.1
Time:				

ID #173978 Time: 825

Rinsate Blank - Filter Blank
Filter - metals. total

ID #173977 Time: 0810

Loc 111 outside house nearest well head.

pH	7.16	7.16
Temp	14.7	14.6
Cond	466.1	461.5
ORP	146.8	144.4

ID# 173979 Time: 0852

173980 Dup.

Loc. 112 spigot nearest well head.

pH	7.33	7.29
Temp	14.7	14.7
Cond	499.4	499.3
ORP	121.5	116.5

ID# 173981 Time: 0922

Loc 103 spigot in the front of the house

pH	7.68	7.55
Temp	17.0	16.7
Cond	455.4	455.4
ORP	106.2	103.7

ID# 173982 Time: 0944

Loc ID 106 BWSD #2 well 1 spigot on well head.

pH	7.55	7.53
Temp	15.6	15.7°C
Cond	454.8	454.0
ORP	75.0	64.6

ID# 173983 Time: 1009

Loc ID 101 spigot in front of building

pH	7.52	7.42
temp	15.5	15.4
Cond	507.5	506.3
ORP	137.0	84.0

ID# 173984 Time: 1040

Loc ID 109 spigot on well head

pH	7.59	7.50
temp	14.9	14.8
Cond	514.8	514.6
ORP	80.3	41.4

ID# 173985 Time: 1100

LOC 110 | spigot on front ~~hose~~ house. next to well head.

pH	7.49	7.49
Temp	15.1	15.0
Cond	543.9	534.5
ORP	82.5	80.0

ID# 173986 Time: 1140

LOC 104 | spigot near workshed.

pH	7.60	7.48
Temp	16.1	16.1
Cond	466.2	462.1
ORP	53.2	33.7

ID# 173987 Time: 1205

LOC 123 | spigot in front of House

pH	7.45	7.43
Temp	14.9	15.6
Cond	579	575
ORP	85.4	187.3

ID# 173988 Time: 1334

LOC 11B | ~~Spgt~~ Spigot on side of house

pH	7.21	7.09
Temp	15.9	~~7.03~~ 15.5
Cond	705	703
ORP	130.5	118.2

ID# 173989 Time: 1400

LOC 102 | spigot in front of the building

pH	7.64	7.56
Temp	17.1	17.0
Cond	429.9	427.8
ORP	106.1	91.7

ID# 173990 Time: 1440

LOC 105 | spigot next well head.

pH	7.67	7.41	7.45
Temp	15.3	15.1	15.2
Cond	467.5	460.1	460.1
ORP	66.1	67.0	73.4

ID# 173991 Time: 1500

Loc ID 167 spigot on well house

pH	7.39	7.36
Temp	15.4	15.2
Cond	442.8	438.6
ORP	78.6	98.2

ID #173992 Time: 1522

Loc 188 spigot on the back of the house

pH	7.59	7.52
Temp	15.4	15.1
Cond	419.7	413.9
ORP	84.7	84.0

ID #173993 Time: 1545

Camdenton Sludge Disposal area
2/13/18

Water quality ex-tech stick check

pH at 7 reads 7.06 ✓
pH at 10 reads 10.02 ✓

Cond at 1413µs reads 1451µs ✓

Loc 10 123 resample

Started Purge 1218
from spigot outside front of house
1st reading at 1223
Temp 11.4°C
Cond 592µs
pH ~~7.70~~ 7.50

2nd reading at 1226
Temp 12.9°C
Cond 437µs
pH 7.45

3rd reading at 1229
Temp = 11.8°C
Cond = 564uS
pH = 7.50

4th reading at 1232
Temp 12.7°C
Cond 577
pH 7.53
Collected Sample at 1233
Sample # 181072

Kitchen Sink (no filter)
Started purge at 1237

1st reading at 1242
Temp = 12.2°C
Cond = 559uS
pH = 7.35

2nd reading at 1245
Temp = 12.1°C
Cond = 551uS
pH = 7.43
Sample collected at 1246
Sample # 181073

Refrigerator Sample (w/ filter)
purged 1000ml before
water quality reading
Temp at 13.7°C
pH = 7.46
Cond = 560uS
Sample collected at 1249
Sample # 181074

Collected from Brita filtered
water in pitcher
Sample collected at 1252
Sample # 181075
WQ parameters were not collected

MEMORANDUM

DATE: November 8, 2017

TO: Valerie Wilder, Environmental Manager
Hazardous Waste Program

THROUGH: Brian Allen, Director
Environmental Services Program

FROM: Kevin Thoenen, Laboratory Manager
Environmental Services Program

SUBJECT: Matrix Interference for Chromium Analysis

On October 2, 2017, Environmental Services Program (ESP) staff collected water samples from drinking water sources in the Camdenton area as a part of the Camdenton Sludge Disposal Site study (Job Code: NJ00CAMD). The samples were submitted to the Chemical Analysis Section (CAS) for total and dissolved Arsenic, Barium, Cadmium, Chromium, Copper, Selenium, Lead, and Zinc by EPA Method 200.8 along with Volatile Organic Compounds by EPA Method 524.2. They were assigned CAS laboratory numbers AD08851 through AD08863 (13 samples). The CAS conducted the dissolved metals analysis directly from a field-filtered, acid-preserved aliquot collected from each water source. For the total metals analysis, an aliquot from an unfiltered, acid-preserved sample was acid digested using the procedure outlined in Section 11.2 of EPA Method 200.8 and subsequently analyzed. Acid digestion for the total metals analysis facilitates detecting any metals that are not readily soluble in the acidified, unfiltered aliquot. Therefore, the total metals analysis would expectedly yield higher results than the dissolved metals analysis from the same water source. However, this was not the case for the chromium results reported for this sampling event. In fact, the analysis for dissolved chromium produced positive results for every sample, while the total chromium analysis was unable to detect chromium in any sample with the exception AD08856, which showed 3.25 parts per billion (ppb) chromium.

The CAS received samples from a second sampling event from drinking water sources in the Camdenton area on October 19, 2017. During the second sampling, a filter blank sample was collected to determine whether chromium was introduced as a trace contaminant during the sampling process for the dissolved metals. The filter blank sample is laboratory grade, purified

water subjected to identical sampling processes for dissolved metals including filtration. These samples were assigned CAS laboratory numbers AD09219 through AD09235 (17 samples).

The CAS conducted metals analysis on the samples from the second sampling event in the same manner as the first. The chromium data showed similar trends, where trace levels were found in all of the dissolved samples, while no chromium was detected in the total samples, again with the exception of one sample, AD09225, which showed 4.41 ppb chromium. In addition, the filter blank showed no detectible levels of chromium, eliminating the possibility of trace contamination from the sampling process.

Given the questionable nature of the dissolved chromium data from both sampling events, CAS staff researched possible false positive interferences with chromium by EPA Method 200.8 that would be removed by the digestion process for total metals analysis. Their research found that naturally occurring carbonates could produce trace level false positive results for chromium. The interfering carbonates would be removed with the acid digestion process during total metals analysis, but not in the dissolved metals analysis since it is a direct analysis and doesn't include a digestion step. Therefore, it was determined that the undigested dissolved metal samples would be subject to interference from carbonates not present in the total metals samples resulting in elevated dissolved chromium readings. In response to this information, the CAS reanalyzed the dissolved chromium on all of the samples from the two sampling events by an alternative, approved method (EPA 200.7). EPA Method 200.7 utilizes different technology to detect chromium and is unaffected by naturally occurring carbonates.

The resulting data from EPA Method 200.7 revealed no detectable dissolved chromium in any of the samples from both sampling events, confirming the false positive interference from the EPA Method 200.8 results. In response, the CAS invalidated the dissolved chromium results reported by EPA Method 200.8 for samples AD08851 through AD08863 and replaced them with the dissolved chromium results obtained by EPA Method 200.7. Addendum reports were subsequently generated and issued for samples AD08851 through AD08863. The dissolved chromium results for samples AD09219 through AD09235 were reported using the data from EPA Method 200.7.

We apologize for any confusion this situation has caused. Please contact me if you have any questions or further concerns.

KT:tt

APPENDIX E

REFERENCES

Combined Preliminary Assessment/Site Inspection Sampling Report

Camdenton Sludge Disposal Area
Camdenton, Missouri
Camden County

Field Activities Conducted
January 6, 1999
January 22, 1999
January 29, 1999

Prepared For:

Missouri Department of Natural Resources
Division of Environmental Quality
Hazardous Waste Program

Prepared By:

Missouri Department of Natural Resources
Division of Environmental Quality
Environmental Services Program

Table of Contents

1.0 Introduction

As authorized under the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986, the Missouri Department of Natural Resources (MDNR), Hazardous Waste Program (HWP), Site Evaluation Unit is conducting a combined preliminary assessment/site inspection (PA/SI) on the Camdenton Sludge Disposal Area (CSDA) site. The MDNR, HWP requested the MDNR, Environmental Services Program (ESP) prepare and implement a sampling plan as part of the combined PA/SI.

Initially, the CSDA was being assessed as part of the Former Hulett Lagoon site. After field activities associated with both the lagoon and the disposal areas were complete, HWP personnel requested the CSDA be considered a separate site, with a separate report generated covering field activities. This report covers field activities conducted in association with the CSDA site. A separate report has been generated which covers field activities associated with the previously established “Former Hulett Lagoon” site.

Field activities associated with the CSDA site were conducted throughout the month of January. Initial groundwater sampling was conducted on January 6, 1999. A soil investigation and sampling was conducted on January 22, 1999. Additional limited groundwater sampling was conducted on January 29, 1999. ESP personnel involved with the various field activities included Environmental Specialists Brian Allen, Ken Hannon, and Doug Thompson. HWP Environmental Specialist Valerie Wilder was present during all field activities conducted. Information learned from field observations and sampling will be used by the HWP in scoring the site’s potential as a hazardous waste site under the CERCLA Hazard Ranking System.

2.0 Site Information

2.1 Location

The CSDA site is located immediately southeast of the Camdenton Memorial Airport and just north of Camden County Road 5-120. The sludge disposal area is approximately 5 miles southeast of the Former Hulett Lagoon site. The legal description is the NE ¼ SE ¼ SE ¼ sec. 4, T. 37 N., R. 16 W.

2.2 Description

The CSDA site is on property owned by the City of Camdenton and is in a rural setting with approximately 5 residences located within ¼ mile. Surface runoff from the site appears to flow to the east and enters a nearby intermittent drainage that continues easterly.

2.3 History/Contaminants of Concern

The following narrative includes pertinent historical information on the former Hulett lagoon, which was one of five lagoons operated by the City of Camdenton prior to the construction of a municipal wastewater treatment plant. The lagoon was in operation from 1961 until approximately 1988, when the City of Camdenton began closure. In addition to municipal wastes, the Hulett lagoon also received wastes generated from a nearby manufacturing facility (discussed below).

In 1967, Dawson Metal Products built a manufacturing facility located approximately ¼ mile southwest of the Hulett lagoon and began operations. Sundstrand Tubular Products purchased the facility in 1972 and continued operations until 1990, when it was purchased by Modine Heat Transfer, Inc., a wholly owned subsidiary of Modine Manufacturing Company. Modine Manufacturing Company currently owns and operates the facility.

From 1967 to the present, manufacturing operations at this facility have consisted of producing air conditioning coils and feeder parts from aluminum and copper tubing, which have included electroplating and the use of solvents. Prior to the construction of the municipal wastewater treatment plant or any facility pretreatment processes, wastes generated from the facility were discharged, in part at least, to the nearby Hulett lagoon.

As part of the Hulett lagoon closure, the city received approval from MDNR to land apply lagoon sludge to an area immediately south of the Camdenton Airport runway now known as the CSDA. Information indicates sampling of the sludge was apparently limited to determining the levels of metals prior to approving the disposal method and that no analyses were conducted for the presence of any volatile organic compounds. The lagoon closure was completed in 1989.

The primary contaminants of concern at the former lagoon and, subsequently, the CSDA include metals and solvents associated with the manufacturing processes from this facility. Specific metals of concern include copper, chromium, lead, and nickel. Various solvents have been used at the facility, including the primary contaminant of concern for this investigation, trichloroethene (TCE). TCE was reportedly used beginning in the early 1970s and continuing to December 1990. It is likely TCE wastes generated at the facility would have been present in the wastestream discharged to the Hulett lagoon and, subsequently, in the sludge transported to the CSDA. HWP personnel have analytical results of a private well sampled in 1998, which is located near the CSDA site and indicates the presence of TCE.

In preparation of drafting a sampling plan for field work, MDNR personnel conducted a reconnaissance of the CSDA site. Personnel were accompanied by a City of Camdenton employee. The city employee pointed out where the lagoon sludge was applied south of the municipal airport, which reportedly totaled approximately 350 truck loads. The employee relayed that attempts to dry the sludge prior to mixing it with surrounding soils, as was stipulated

in the approved MDNR disposal method, were unsuccessful and that the sludge was eventually simply laid out on the ground surface over a large area surrounding the airport runway. The employee also indicated that a significant amount of the lagoon sludge was placed in a topographically low area, which has since migrated to areas downgradient via surficial runoff.

The MDNR, HWP has extensive file information on the manufacturing facility and the lagoon closure, which should be referenced for a more comprehensive review of historic regulatory activities.

3.0 Methods

3.1 General Field Procedures

A health and safety briefing was conducted on-site and personnel read and signed the site-specific health and safety plan prior to initiating field activities.

Missouri One-Call was notified of proposed field activities prior to ESP personnel arriving on-site, and all applicable underground utilities were marked.

Field instruments, including a photoionization detector (PID), pH, specific conductivity, and temperature meters were calibrated on-site following manufacturers' specifications.

ESP personnel employed established standard operating procedures for the collection of various samples. Containers for each sample were filled based upon the volatility of the analytes of concern with the most volatile analytes being collected first. All samples were collected in certified-clean containers and preserved in the field as appropriate.

ESP personnel collected depth-discrete soil grab samples in selected source areas and groundwater samples from selected private wells, municipal/public wells, and monitoring wells in an effort to determine the types of hazardous wastes which may be present, whether a hazardous substance release has occurred to the environment, and whether the substances have impacted, or may impact, human health and/or the environment. Background samples were also collected of each media sampled from areas that would not appear to be impacted from the site.

An ESP global positioning system (GPS) unit was taken to the field and used to determine the geographic coordinates of each sample location. All sample locations and descriptions were noted in a bound field logbook and locations noted on a site map.

3.2 Groundwater Sampling

Specific conductivity, pH, and temperature were determined for each sample at the time of collection. Personnel attempted to gain pertinent information on each well sampled (age,

construction, depth, casing length, screened interval, location of tap, etc.) and record such into the field logbook.

Groundwater grab samples were collected of several private wells located in the vicinity of the CSDA as well as a Camden County Public Water Supply District well located on the Camden Municipal Airport property.

Samples were collected from taps nearest the well heads after opening the tap at a high flow for approximately five minutes. Sample containers were then filled directly from the taps at a low flow.

Based upon concerns from private citizens who live in close proximity to the CSDA, ESP personnel collected several additional grab samples from two private wells located near the sludge disposal area. The additional samples were collected at specific times during well evacuations. Refer to the Observations section for further discussion regarding the additional samples collected.

3.3 Soil Sampling

A membrane interface probe (MIP) was employed to generate soil gas data of the subsurface within and surrounding the boundaries of the CSDA. The soil gas data was used, in part, to determine actual sampling locations.

Soil grab samples were collected from discrete depths utilizing a track-mounted hydraulic soil probe. Clean disposable acetate liners were used in conjunction with the soil probe and inserted into stainless steel macro core samplers fitted with clean cutting shoes. The core samplers were advanced to the desired sampling depth via push tubes and the samplers and soil retrieved. The acetate liners were removed and cut open exposing the soil. Personnel immediately collected soils to be submitted for volatile organics analyses with clean EnCore® sampling devices (two 5gm aliquots). An additional aliquot for volatile organics analyses was collected in a 2-oz glass jar, as a backup. Soils to be submitted for the additional analytes of concern were transferred with clean stainless steel spoons to clean aluminum foil pans, homogenized, then placed into appropriate sample containers.

3.4 Sample Quantity

A total of ten soil grab samples and 14 water grab samples were collected during field activities associated with the CSDA site and submitted to the ESP laboratory for analyses. An additional four water grab samples were collected and submitted to a contract laboratory for quality control. These sample numbers include quality assurance/quality control samples. Refer to Table 1 for a listing of all samples collected.

3.5 Analyses Requested

Based on the history of the site and HWP data needs, the following analyses were requested. Water grab samples collected during the January 6, 1999, field work and all soil grab samples were submitted for volatile organics and total metals (As, Ba, Cr, Cd, Cu, Pb, Ni, Hg, Se, Ag) analyses. Instructions were relayed to analytical personnel that if a sample's total analyte results were 80% of twenty times the Toxicity Characteristic Leaching Procedure (TCLP) regulatory limit, TCLP analysis was to be performed on that sample. Additionally, drinking water detection limits were requested for any water grab samples, where no contaminants were observed above the standard practical quantitation limits. The water grab samples collected on January 29, 1999, were submitted for volatile organics analyses (drinking water detection limits) only.

3.6 Chain of Custody

All samples received a numbered label and the corresponding number was entered onto a chain of custody form indicating the location, date and time of collection, and analytes requested. Samples were stored and transported on ice in coolers. ESP field personnel maintained custody of the samples until relinquishing them to a sample custodian at the state's environmental laboratory within the Environmental Services Program in Jefferson City for analyses.

4.0 Data Quality

To help ensure precise, accurate, representative, complete, and comparable data were achieved, all field work and analyses were conducted in accordance with the Fiscal Year 1999 Quality Assurance Project Plan for Pre-Remedial Site Assessments dated August 14, 1998. Unless otherwise noted, ESP field personnel utilized standard operating procedures established within the ESP, Field Services Section for all samples collected.

4.1 Field Methods

Clean disposable nitrile gloves were worn by sampling personnel and clean equipment utilized for each separate sample collected to minimize the possibility of cross-contamination.

Field personnel noted all observations, sample locations, descriptions, and methods in a bound field logbook.

4.2 Field Decontamination

Field decontamination of sampling equipment was not required during the sampling event.

4.3 Quality Assurance/Quality Control Samples

4.3.1 Trip blanks

Two trip blanks were submitted as part of the field activities associated with the CSDA site. One trip blank accompanied water samples submitted to ESP for analyses. The second trip blank

accompanied a batch of samples submitted to a contract laboratory. The trip blanks were taken to the field and accompanied samples collected and transported back to the laboratories. The trip blanks received numbered labels, were entered onto the chain of custody forms, and were submitted for volatile organics analyses.

4.3.2 Duplicate sample (water)

One duplicate water grab sample was collected and submitted for the sampling event. The duplicate sample was collected at the same location and time as its true sample, using similar technique and equipment. The duplicate sample received a numbered label, was entered onto the chain of custody form, and submitted for the same analytes as its true sample.

4.3.3 Replicate sample (soil)

One replicate soil grab sample was collected and submitted for the sampling event. The replicate sample was collected by dividing the true sample evenly into two separate samples and submitting each for laboratory analyses. The portion of each true/replicate sample pair submitted for volatile organics was not homogenized prior to collection. The remaining soil was homogenized prior to splitting the true sample into two samples. The replicate sample received a numbered label, was entered onto the chain of custody form, and submitted for the same analytes as its true sample.

5.0 Investigation Derived Wastes (IDW)

Efforts were made to minimize IDW generation. IDW included soil, aqueous liquids (groundwater), disposable sampling equipment, and disposable personal protective equipment (PPE).

Field personnel returned unused soils to their source immediately after generation. IDW generated during private and public well evacuation was discharged to the ground. Disposable PPE and disposable sampling equipment were handled as solid waste, containerized, and properly disposed.

6.0 Observations

6.1 General

A significant snow event occurred on January 2, 1999. As a result of the snow-cover diminishing ground visibility and equipment access, field activities conducted on January 6-7, 1999, were limited to the collection of groundwater samples only. The weather on January 6, 1999, was sunny and approximately 30 degrees Fahrenheit with winds light and variable.

Personnel returned to the site on January 22, 1999, once snow had melted, to conduct the soil investigation and sampling. The weather on January 22, 1999, was overcast and ranged from 40

to 45 degrees Fahrenheit with winds light and variable. Light, intermittent rains occurred throughout the day and fog was prevalent.

The weather on January 29, 1999, was overcast and approximately 40 degrees Fahrenheit with winds light and variable.

GPS coordinates of all sampling points were post-processed at ESP and entered onto a map of the site. Refer to Table 2 for a listing of all sampling point coordinates and Appendix A for the locations of all samples collected.

6.2 Groundwater Sampling

ESP personnel collected two sets of 40-ml vials for volatile organics analyses on all water grab samples collected on January 6, 1999. The first set of vials in each sample was submitted for volatile organics analyses using the standard quantitation limits for water samples (as specified in the QAPP). Per a request from HWP, in the event contaminant levels in a given sample were non-detect, the second set of vials was analyzed to realize the lower drinking water detection limits.

All samples collected from public and private wells were noted to be clear and colorless.

Two citizens (Larry Coleman and Pepper Coffman) whose properties are located adjacent to the CSDA, and who have private wells, collected grab samples of their respective wells shortly after ESP personnel had sampled the wells on January 6, 1999. The samples collected by the property owners were sent to an independent laboratory. Preliminary ESP analytical results indicated no contaminants were present in either well, while the well owners' independent analytical results indicated TCE was present in both wells. A result of 21 ppb TCE was reported present in the Coleman well and a result of 20 ppb TCE was reported present in the Coffman well. Due to the discrepancies between the laboratories, HWP offered to resample the wells, and split samples with the property owners, on January 29, 1999. In addition to splitting samples with the respective property owners, arrangements were made to submit additional split samples to an ESP contract laboratory as a further quality control check.

Sampling at various time intervals was conducted for several reasons. First, a previous sample collected by the City of Camdenton of the Coffman residential well had reported 13 ppb TCE present. This sample had reportedly been collected after a short, unspecified, evacuation time. A subsequent confirmatory sample was collected by the City after evacuating the Coffman well for approximately 30 minutes in which no TCE was detected. On January 6, 1999, ESP personnel had collected one set of samples of the Coffman well after an approximate 30 second evacuation time and an additional set of samples after evacuating the well for five minutes. Neither of these samples, nor the ESP sample collected on the same date of the Coleman well, showed any volatile organics contaminants were detected. When the property owners'

independent samples, collected shortly after January 6, 1999, detected TCE in both wells, the decision was made to attempt to reproduce the sample collection method employed by the property owners.

ESP and HWP personnel returned to the respective properties on January 29, 1999, and collected samples at several timed intervals (after 15 minutes, 45 minutes, and 75 minutes of evacuation) of both the Coleman and Coffman wells. During a conversation with Mr. Coleman on this date, he indicated that he had previously collected his and Mr. Coffman's independent samples by filling one 40-ml vial shortly after "clearing the lines" (within the first few seconds of evacuation) in each well and then filling the second 40-ml vial in each sample after evacuating each well an additional approximate 30 minutes. There is no way of determining which vial in each sample set was analyzed by the independent laboratory. As a result of this information, ESP also collected a grab sample of the Coleman well within 15 seconds of initiating evacuation.

6.3 Soil Sampling

During the MIP investigation and soil sampling, personnel generally encountered refusal at depths ranging from five to six feet at the CSDA. A total of nine MIP borings were performed during the field activities associated with the CSDA. Samples were collected from specific MIP locations based upon the soil gas data generated and the boring locations relative to the areas of concern. Soil samples collected were generally noted to consist of reddish-brown cherty clays with varying amounts of gravel interspersed. Due to the nature of the matrix, sample homogenization was difficult.

Refer to Appendix B for the MIP data logs generated for each boring and the site map for the MIP boring and soil sampling locations. The logs indicate detections noted on the MIP's PID, identified as "Detector 1" and the flame ionization detector "Detector 2".

7.0 Analytical Results

The analytical results of samples collected are attached as Appendix C.

Submitted by: __________________________

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Date: __________________________

Approved by: __________________________

James H. Long
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APPENDIX A
Site Maps
Camdenton Sludge Disposal Area Site
Camdenton, Missouri

APPENDIX B
MIP Data Logs
Camdenton Sludge Disposal Area Site
Camdenton, Missouri

APPENDIX C
Analytical Results
Camdenton Sludge Disposal Area Site
Camdenton, Missouri

TABLES

Camdenton Sludge Disposal Area Site

Camdenton, Missouri

Table 2
Camdenton Sludge Disposal Area Site
GPS Data Points

GPS Identification	Location/ Description	Latitude (Degrees N)	Longitude (Degrees W)	ArcView Data Points (UTM)	
				Easting	Northing
A010617B	Coffman residential well	+37.969595º	-92.690551º	527181	4202487
A010618A	Coleman residential well	+37.966704º	-92.684321º	527728	4202168
A010618B	Daniels residential well	+37.965898º	-92.684275º	527733	4202078
A012214A	Boring “Hulett 11”	+37.968718	-92.687884	527415	4202390
A012215A	Boring “Hulett 12”	+37.969064	-92.687916	527412	4202429
A012217C	Boring “Hulett 13”	+37.969054	-92.688244	527383	4202427
A012217B	Boring “Hulett 14”	+37.969095	-92.687724	527429	4202432
A012217A	Boring “Hulett 15”	+37.969301	-92.687977	527406	4202455
A012217D	Boring “Hulett 16”	+37.969667	-92.688283	527379	4202495
A012217E	Boring “Hulett 17”	+37.970089	-92.688573	527354	4202542
A012218B	Boring “Hulett 18”	+37.968940	-92.687953	527408	4202415
A012218C	Boring “Hulett 19”	+37.968930	-92.688234	527384	4202414
A012219A	Boring “Hulett 20”	+37.968634	-92.688634	527349	4202381

Table 1
Camdenton Sludge Disposal Area Site
Sample Listing

Sample #	Sample Media/Type	Location Collected	Date/Time Collected
991454	Water grab	Pepper Coffman residential well (3499 County Rd 5-120), collected after 30 seconds evacuation time.	1/6/99 @ 1135
991455	Water grab	Pepper Coffman residential well, collected after approximately 5 minutes evacuation time.	1/6/99 @ 1145
991456	Water grab	Larry Coleman residential well (3496 County Rd 5-120), collected after approximately 5 minutes evacuation time.	1/6/99 @ 1205
991457	Water grab	Kerry Daniels residential well (residence immediately south of Coleman residence), collected after approximately 5 minutes evacuation time.	1/6/99 @ 1220
991476	Soil grab	Boring "Hulett-11", collected from the 0.5-1 ft depth.	1/22/99 @ 0900
991477	Soil grab	Boring "Hulett-12", collected from the 8.5-9 ft depth.	1/22/99 @ 0950
991478	Soil grab	Boring "Hulett-12", collected from the 0.5-1 ft depth.	1/22/99 @ 1010
991479	Soil grab	Boring "Hulett-17", collected from the 0.5-1 ft depth.	1/22/99 @ 1215
991480	Soil grab	Boring "Hulett-18", collected from the 5.5-6 ft depth.	1/22/99 @ 1245
991481	Soil grab	Boring "Hulett-19", collected from the 7-7.5 ft depth.	1/22/99 @ 1340
991482	QA/QC sample (Replicate)	Replicate sample of 991481.	1/22/99 @ 1340
991483	Soil grab	Boring "Hulett-19", collected from the 0.5-1 ft depth.	1/22/99 @ 1350
991484	Soil grab	Boring "Hulett-20", collected from the 0.5-1 ft depth.	1/22/99 @ 1410
991485	Soil grab	Boring "Hulett-20", collected from the 5.5-6 ft depth.	1/22/99 @ 1425
991486	QA/QC sample (Trip blank)	ESP laboratory.	1/28/99
991487	Water grab	Pepper Coffman residential well, collected after 15 minutes evacuation time.	1/29/99 @ 0950
991488	Water grab	Pepper Coffman residential well, collected after 45 minutes evacuation time.	1/29/99 @ 1020
991489	QA/QC sample (Duplicate)	Duplicate sample of 991488..	1/29/99 @ 1020
991491	Water grab	Larry Coleman residential well, collected after 15 seconds evacuation time.	1/29/99 @ 1030
991492	Water grab	Larry Coleman residential well, collected after 15 minutes evacuation time.	1/29/99 @ 1045
991493	Water grab	Pepper Coffman residential well, collected after 75 minutes evacuation time.	1/29/99 @ 1050
991494	Water grab	Larry Coleman residential well, collected after 45 minutes evacuation time.	1/29/99 @ 1115
991495	Water grab	Larry Coleman residential well, collected after 75 minutes evacuation time.	1/29/99 @ 1145
991496	Water grab	Camden County PWDS #2 well #1, collected after 10 minutes evacuation time.	1/29/99 @ 0920
The following samples were collected and submitted to an ESP contract laboratory as analytical QC samples			
991411	Water grab	Pepper Coffman residential well, collected after 45 minutes evacuation time **(split of 991488)**.	1/29/99 @ 1020
991412	Water grab	Larry Coleman residential well, collected after 15 minutes evacuation time **(split of 991492)**	1/29/99 @ 1045
991413	Water grab	Larry Coleman residential well, collected after 45 minutes evacuation time **(split of 991494)**	1/29/99 @ 1115
991490	QA/QC sample (Trip blank)	ESP laboratory	1/28/99

Chromium - ToxFAQs™

CAS # 7440-47-3

This fact sheet answers the most frequently asked health questions (FAQs) about chromium. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to chromium occurs from ingesting contaminated food or drinking water or breathing contaminated workplace air. Chromium(VI) at high levels can damage the nose and cause cancer. Ingesting high levels of chromium(VI) may result in anemia or damage to the stomach or intestines. Chromium(III) is an essential nutrient. Chromium has been found in at least 1,127 of the 1,669 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is chromium?

Chromium is a naturally occurring element found in rocks, animals, plants, and soil. It can exist in several different forms. Depending on the form it takes, it can be a liquid, solid, or gas. The most common forms are chromium(0), chromium(III), and chromium(VI). No taste or odor is associated with chromium compounds.

The metal chromium, which is the chromium(0) form, is used for making steel. Chromium(VI) and chromium(III) are used for chrome plating, dyes and pigments, leather tanning, and wood preserving.

What happens to chromium when it enters the environment?

- Chromium can be found in air, soil, and water after release from the manufacture, use, and disposal of chromium-based products, and during the manufacturing process.
- Chromium does not usually remain in the atmosphere, but is deposited into the soil and water.
- Chromium can easily change from one form to another in water and soil, depending on the conditions present.
- Fish do not accumulate much chromium in their bodies from water.

How might I be exposed to chromium?

- Eating food containing chromium(III).
- Breathing contaminated workplace air or skin contact during use in the workplace.
- Drinking contaminated well water.
- Living near uncontrolled hazardous waste sites containing chromium or industries that use chromium.

How can chromium affect my health?

Chromium(III) is an essential nutrient that helps the body use sugar, protein, and fat.

Breathing high levels of chromium(VI) can cause irritation to the lining of the nose, nose ulcers, runny nose, and breathing problems, such as asthma, cough, shortness of breath, or wheezing. The concentrations of chromium in air that can cause these effects may be different for different types of chromium compounds, with effects occurring at much lower concentrations for chromium(VI) compared to chromium(III).

The main health problems seen in animals following ingestion of chromium(VI) compounds are irritation and ulcers in the stomach and small intestine and anemia. Chromium(III) compounds are much less toxic and do not appear to cause these problems.

Sperm damage and damage to the male reproductive system have also been seen in laboratory animals exposed to chromium(VI).

Skin contact with certain chromium(VI) compounds can cause skin ulcers. Some people are extremely sensitive tochromium(VI) or chromium(III). Allergic reactions consisting of severe redness and swelling of the skin have been noted.

Chromium

CAS # 7440-47-3

How likely is chromium to cause cancer?

The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have determined that chromium(VI) compounds are known human carcinogens.

In workers, inhalation of chromium(VI) has been shown to cause lung cancer. Chromium(VI) also causes lung cancer in animals. An increase in stomach tumors was observed in humans and animals exposed to chromium(VI) in drinking water.

How can chromium affect children?

It is likely that health effects seen in children exposed to high amounts of chromium will be similar to the effects seen in adults.

We do not know if exposure to chromium will result in birth defects or other developmental effects in people. Some developmental effects have been observed in animals exposed to chromium(VI).

How can families reduce the risk of exposure to chromium?

- Children should avoid playing in soils near uncontrolled hazardous waste sites where chromium may have been discarded.
- Chromium is a component of tobacco smoke. Avoid smoking in enclosed spaces like inside the home or car in order to limit exposure to children and other family members.
- Although chromium(III) is an essential nutrient, you should avoid excessive use of dietary supplements containing chromium.

Is there a medical test to determine whether I've been exposed to chromium?

Since chromium(III) is an essential element and naturally occurs in food, there will always be some level of chromium in your body. Chromium can be measured in hair, urine, and blood.

Higher than normal levels of chromium in blood or urine may indicate that a person has been exposed to chromium. However, increases in blood and urine chromium levels cannot be used to predict the kind of health effects that might develop from that exposure.

Has the federal government made recommendations to protect human health?

The EPA has established a maximum contaminant level of 0.1 mg/L for total chromium in drinking water.

The FDA has determined that the chromium concentration in bottled drinking water should not exceed 0.1 mg/L.

The Occupational Health and Safety Administration (OSHA) has limited workers' exposure to an average of 0.005 mg/m^3 chromium(VI), 0.5 mg/m^3 chromium(III), and 1.0 mg/m^3 chromium(0) for an 8-hour workday, 40-hour workweek.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2012. Toxicological Profile for Chromium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Trichloroethylene - ToxFAQs™

CAS # 79-01-6

This fact sheet answers the most frequently asked health questions (FAQs) about trichloroethylene. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Trichloroethylene is used as a solvent for cleaning metal parts. Exposure to very high concentrations of trichloroethylene can cause dizziness, headaches, sleepiness, incoordination, confusion, nausea, unconsciousness, and even death. The Environmental Protection Agency (EPA) and the International Agency for Research on Cancer (IARC) classify trichloroethylene as a human carcinogen. Trichloroethylene has been found in at least 1,045 of the 1,699 National Priorities List sites identified by the EPA.

What is trichloroethylene?

Trichloroethylene is a colorless, volatile liquid. Liquid trichloroethylene evaporates quickly into the air. It is nonflammable and has a sweet odor.

The two major uses of trichloroethylene are as a solvent to remove grease from metal parts and as a chemical that is used to make other chemicals, especially the refrigerant, HFC-134a. Trichloroethylene was once used as an anesthetic for surgery.

What happens to trichloroethylene when it enters the environment?

- Trichloroethylene can be released to air, water, and soil at places where it is produced or used.
- Trichloroethylene is broken down quickly in air.
- Trichloroethylene breaks down very slowly in soil and water and is removed mostly through evaporation to air.
- It is expected to remain in groundwater for long time since it is not able to evaporate.
- Trichloroethylene does not build up significantly in plants or animals.

How might I be exposed to trichloroethylene?

- Breathing trichloroethylene in contaminated air.
- Drinking contaminated water.
- Workers at facilities using this substance for metal degreasing are exposed to higher levels of trichloroethylene.
- If you live near such a facility or near a hazardous waste site containing trichloroethylene, you may also have higher exposure to this substance.

How can trichloroethylene affect my health?

Exposure to moderate amounts of trichloroethylene may cause headaches, dizziness, and sleepiness; large amounts may cause coma and even death. Eating or breathing high levels of trichloroethylene may damage some of the nerves in the face. Exposure to high levels can also result in changes in the rhythm of the heartbeat, liver damage, and evidence of kidney damage. Skin contact with concentrated solutions of trichloroethylene can cause skin rashes.

There is some evidence exposure to trichloroethylene in the work place may cause scleroderma (a systemic autoimmune disease) in some people. Some men occupationally-exposed to trichloroethylene and other chemicals showed decreases in sex drive, sperm quality, and reproductive hormone levels.

How likely is trichloroethylene to cause cancer?

There is strong evidence that trichloroethylene can cause kidney cancer in people and some evidence for trichloroethylene-induced liver cancer and malignant lymphoma. Lifetime exposure to trichloroethylene resulted in increased liver cancer in mice and increased kidney cancer and testicular cancer in rats.

The National Toxicology Program (NTP) has determined that trichloroethylene is a "known human carcinogen". The EPA and the International Agency for Research on Cancer (IARC) have determined that trichloroethylene is "carcinogenic to humans."

Trichloroethylene

CAS # 79-01-6

How can trichloroethylene affect children?

It is not known whether children are more susceptible than adults to the effects of trichloroethylene.

Some human studies indicate that trichloroethylene may cause developmental effects such as spontaneous abortion, congenital heart defects, central nervous system defects, and small birth weight. However, these people were exposed to other chemicals as well.

In some animal studies, exposure to trichloroethylene during development caused decreases in body weight, increases in heart defects, changes to the developing nervous system, and effects on the immune system.

How can families reduce the risk of exposure to trichloroethylene?

- Avoid drinking water from sources that are known to be contaminated with trichloroethylene. Use bottled water if you have concerns about the presence of chemicals in your tap water. You may also contact local drinking water authorities and follow their advice.
- Discourage your children from putting objects in their mouths. Make sure that they wash their hands frequently and before eating.
- Prevent children from playing in dirt or eating dirt if you live near a waste site that has trichloroethylene.
- Trichloroethylene is used in many industrial products. Follow instructions on product labels to minimize exposure to trichloroethylene.

Is there a medical test to show whether I've been exposed to trichloroethylene?

Trichloroethylene and its breakdown products (metabolites) can be measured in blood and urine. However, the detection of trichloroethylene or its metabolites cannot predict the kind of health effects that might develop from that exposure. Because trichloroethylene and its metabolites leave the body fairly rapidly, the tests need to be conducted within days after exposure.

Has the federal government made recommendations to protect human health?

The EPA set a maximum contaminant goal (MCL) of 0.005 milligrams per liter (mg/L; 5 ppb) as a national primary drinking standard for trichloroethylene.

The Occupational Safety and Health Administration (OSHA) set a permissible exposure limit (PEL) of 100 ppm for trichloroethylene in air averaged over an 8-hour work day, an acceptable ceiling concentration of 200 ppm provided the 8 hour PEL is not exceeded, and an acceptable maximum peak of 300 ppm for a maximum duration of 5 minutes in any 2 hours.

The National Institute for Occupational Safety and Health (NIOSH) considers trichloroethylene to be a potential occupational carcinogen and established a recommended exposure limit (REL) of 2 ppm (as a 60-minute ceiling) during its use as an anesthetic agent and 25 ppm (as a 10-hour TWA) during all other exposures.

References

This ToxFAQs™ information is taken from the 2014 Toxicological Profile for Trichloroethylene (Draft for Public Comment) produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Ion the web: www.atsdr.cdc.gov/toxFAQs.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Missouri Department of NATURAL RESOURCES

dnr.mo.gov

Eric R. Greitens, Governor   Carol S. Comer, Director

MEMORANDUM

STATE OF MISSOURI
BRENNA E McDONALD
RG
REGISTERED GEOLOGIST

4 pages w/attachments

DATE: September 8, 2017

TO: Amanda Branson, Environmental Specialist
Keith Brown, Environmental Specialist
Hazardous Waste Program,
Division of Environmental Quality (DEQ)

FROM: Peter Bachle, Geologist
Geological Survey Program,
Missouri Geological Survey (MGS)

SUBJECT: Addendum Geohydrologic Summary of Camdenton TCE Sites

LOCATION: Camdenton, Camden County, Missouri
Approximately 37.9988° North Latitude and 92.7634° West Longitude
(Dawson Metal Products Facility #2)
Approximately 38.0115° North Latitude and 92.7547° West Longitude
(Hulett Lagoon)
Approximately 37.9696° North Latitude and 92.6867° West Longitude
(Camdenton Sludge Disposal)

This is an addendum to the March 1999 geohydrologic reports for the Camdenton Sludge Disposal and Hulett Lagoon sites in addition to the recently discovered Dawson Metal Products Facility #2 site. This report is prepared in order to aid in determining optimum sampling locations and identifying potential groundwater receptors for site originated contaminants.

The primary contaminants of concern at the sites are the chlorinated solvent trichloroethylene (TCE) and the daughter products of degradation. These compounds are dense non-aqueous phase liquids (DNAPLs) that sink through the water column with very slight dissolution in water. The free product will descend deep into the aquifer while the dissolved phase plume will migrate in the down gradient direction of groundwater flow, this being due to natural gradients and water well cones of depression.

A secondary contaminant of concern is chromium. This contaminant is likely to bind with soil particles. Therefore, the extent of the chromium contamination may be limited to the unconsolidated materials at and near the disposal areas.

LOCATIONS

The three Camdenton TCE sites discussed within this document are as follows; the Dawson Metal Products Facility #2 (Dawson site) located on the north side of Highway 54 between Camdenton and the Lake of the Ozarks, the Hulett Lagoon and associated Modine site located on the west side of Camdenton, and the Camdenton Sludge Disposal site located approximately 3 miles southeast of Camdenton near the Camdenton Memorial Airport. The Dawson site is located on a ridge that has steep slopes descending to the northeast, north, and northwest. The Hulett Lagoon site is a dry lagoon located in the upper reaches of a valley that lies north of the Modine facility. The valley drains west toward the Lake of the Ozarks. The Camdenton Sludge Disposal site is located along a ridge at the southeast end of the Camdenton Memorial Airport.

GROUNDWATER PATHWAY

The Ordovician-age Gasconade Dolomite and Roubidoux Formation underlie the sites. These formations are part of the Ozark Aquifer. There are no known confining layers between the ground surface and the water table that would prevent migration of surface contaminants from reaching the aquifer at or near the location of the sites. In the case of all three locations, the bedrock has substantial secondary porosity development, or karst. The local classified losing stream segments, springs, caves, and 10- to 65-foot voids encountered in local wells attest to this.

According to drinking water well data, the water table within the Ozark Aquifer near the Dawson site lies close to the same elevation as the Lake of the Ozarks, that being between 660 to 675 feet above mean sea level (amsl). This puts the depth to groundwater for the Dawson site at 285 to 300 feet below ground surface (bgs). Based upon drinking water well data, the water table elevation beneath the Hulett Lagoon site lies somewhere between 700 and 865 feet amsl with 820 to 830 feet amsl being the most likely range near the lagoon. That places the depth to groundwater at the Hulett Lagoon site at 110 to 120 feet bgs. The elevation of groundwater near the Camdenton Sludge Disposal site lies between 765 and 790 feet amsl. That makes the depth to groundwater beneath the site range from 230 to 295 feet bgs. Since the primary site contaminants are chlorinated solvents, any wells that draw water from near the site are potential receptors. In the case of the Hulett Lagoon/Modine site, the dissolved TCE plume has been detected in the Mulberry Street public well which has a 400-foot-deep casing, a total depth of 900 feet, and lies between 740 to 1100 feet southeast of the potential source regions.

Since the bedrock in the area appears to have high karst development, the delineation of a contaminant plume may be complex. The contaminant plume may extend farther by entering cave streams, take preferential pathways and miss proximal wells, disperse laterally along more competent bedrock bedding planes, or get drawn toward high yield wells. Adding to the lateral complexity of the plume is the possible existence of domestic

wells at now-non-existent residences documented to be located at the south corner of the Dawson site property prior to 1968. Improperly abandoned wells can create preferential downward migration pathways.

Based upon static water level data from the Logmain and WIMS databases, there is a steep groundwater gradient toward the Lake of the Ozarks. Therefore, the dissolved phase of the chlorinated solvent plume most likely will migrate toward the lake. For all three site locations, the plume migration is, in general, toward the west and may impact springs that lie between the sites and the lake. In the case of the Dawson site, Cullen spring (elevation 700 feet amsl) and an unnamed spring (elevation 740 feet amsl) may be potential receptors.

The MGS drinking water well databases contain records of three municipal, one community public, one non-community public, and thirteen domestic wells within a ½-mile radius of the Camdenton TCE sites. On Table 1, Logmain well number 27877 and Public Water Supply Program well number 103793 are both associated the Camdenton municipal Blair Heights well.

Prior to 1987, registry of private wells was not required. Therefore, existing older wells may not be included in the database. Also, proper well registration may not have been submitted for some wells. Because of these exceptions, the databases may not accurately reflect all of the water usage in this area.

Figure 1 illustrates the recorded locations of the 18 known water wells within a ½-mile radius of the sites. Table 1 lists specific technical attributes (total and casing depth, static water level, date drilled, yield, etc.) of the water wells. In addition to well locations, Figure 1 illustrates the municipal water supply coverage area, county water supply district coverage area, regional groundwater elevation, classified gaining and losing stream segments, and known springs. All of these were used in determining groundwater depth, flow direction, and groundwater use for the sites.

SURFACE WATER PATHWAY

Surface water leaving the potential source area for the Dawson site flows north across the parking lot before descending the steep hill and entering a losing stream segment that drains toward the west. This stream changes to gaining near the lake level, meaning the surface water entering the ground along the losing length of the stream begins to discharge to the surface near the lake.

On August 23, 2017, Geological Survey Program (GSP) personnel were on-site at the Dawson site and observed that surface water had pooled along the southwest side of the building and was flowing into the steep valley located northwest of the building. It had been several days since the last rain fall, which indicates that the ground near the facility was saturated at the time of the site visit. It is not currently known how persistent, or whether there is, a perched water table beneath the site.

Surface water leaving the Hulett Lagoon site flows west down a steep hill, along a losing stream segment until it changes to gaining near the surface of the Lake of the Ozarks. The end of the losing segment downstream from the Hulett Lagoon site lies close to the end of the intermittent segment that is downstream of the Dawson site.

Surface water leaving the Camdenton Sludge Disposal site most likely flows to the northeast and/or southeast into classified losing stream segments. Water entering these streams will most likely enter the ground, thereby becoming groundwater, ultimately flowing west toward the lake.

RECOMMENDATIONS

Since the contaminant plume is not yet defined, it is recommended that drinking water wells located within 0.5 mile of the potential TCE disposal sites be sampled. Due to the sinking nature of the primary contaminant, surface casing may not be protective against TCE contamination. Since the recording of well data was sporadic prior to December 1986, a door-to-door well search is advisable. Due to the apparent groundwater gradient toward the Lake of the Ozarks, preferential sampling is advised to the west side of the sites. It is suggested that Cullen Spring and the unnamed spring located southwest and south of the Dawson site be sampled. If surface water still persists at the Dawson site, it is suggested that samples are taken from the valley near the northwest corner of the Dawson site building.

REFERENCES

Water Resource Program. (unpublished). *Well logs from Logmain database*. Missouri Department of Natural Resources-Directors Office.

Wellhead Protection Program. (unpublished). *Well information management system database (WIMS)*. Missouri Department of Natural Resources-Missouri Geological Survey.

Missouri Department of NATURAL RESOURCES

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Eric R. Greitens, Governor

Carol S. Comer, Director

MEMORANDUM

STATE OF MISSOURI
BRENNA E McDONALD
RG
2016011411
REGISTERED GEOLOGIST

Brenna E McDonald

1 page w/attachments
9/13/17

DATE: September 13, 2017

TO: Keith Brown, Environmental Specialist,
Hazardous Waste Program,
Division of Environmental Quality (DEQ)

FROM: Peter Bachle, Geologist Peter J Bachle
Geological Survey Program,
Missouri Geological Survey (MGS)

SUBJECT: Four-Mile Well Survey for the Camdenton Sludge Disposal Site

LOCATION: SE ¼ Section 4, Township 37 North, Range 16 West, Decaturville 7.5-Minute Quadrangle, Camden County, Missouri
Approximately 37.9696° North Latitude and 92.6867° West Longitude

FOUR-MILE WELL SURVEY

The Public Drinking Water Program (PDWP) public well, Wellhead Protection Section's Well Information Management System (WIMS), and the Logamin well log databases were assessed in order to determine the wells that are currently known to exist within 4 miles of the Camdenton Sludge Disposal site. Based upon the available information, there 287 known wells located within 4 miles of the site. There are records of one municipal, 12 community public, two non-community public, and 272 domestic wells within a 4-mile radius of the site. The nearest domestic drinking water well on record is located approximately 0.1 mile south of the site. The nearest public well on record is located approximately 0.26 mile northwest of the site.

Figure 2 illustrates the recorded locations of the 287 known water wells within a 4-mile radius of the site. Table 2 lists specific technical attributes (total and casing depth, static water level, date drilled, yield, etc.) of the water wells

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Table 2: Well Data for the Camdenton Sludge Disposal Site

Water wells located within 4 miles of the Camdenton Sludge Disposal site.

0 to 0.25 Mile

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
WIMS	189083	433	80	--	245	1997	Domestic	--	Ozark Aquifer	30

Wells found within 0 to 0.25 mile of the site: 1

0.25 to 0.5 Mile

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
WIMS	52609	395	148	--	210	1991	Domestic	--	Ozark Aquifer	30
WIMS	189094	233	125	--	105	1997	Domestic	--	Ozark Aquifer	20
WIMS	255044	340	100	--	90	2000	Domestic	--	Ozark Aquifer	50
WIMS	296521	450	118	--	285	2004	Domestic	--	Ozark Aquifer	28
WIMS	368177	420	160	--	270	2006	Domestic	--	Ozark Aquifer	20

Wells found within 0.25 to 0.5 mile of the site: 5

0.5 to 1 Mile

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
PDWP	105015	--	--	1060	--	--	Non-community Public	Speedline Technologies Inc.	Ozark Aquifer	--
PDWP	103795	848	330	--	271	1974	Community Public	Camden Co. PWSD #2	Ozark Aquifer	83
PDWP	105943	--	--	--	--	--	Community Public	Seven Hills Apartments	Ozark Aquifer	--
WIMS	10774	400	230	--	305	1988	Domestic	--	Ozark Aquifer	20
WIMS	26772	261	107	--	--	1989	Domestic	--	Ozark Aquifer	35
WIMS	226733	260	80	--	105	2002	Domestic	--	Ozark Aquifer	25
WIMS	263100	395	105	--	195	2001	Domestic	--	Ozark Aquifer	35
WIMS	288263	410	120	--	240	2002	Domestic	--	Ozark Aquifer	25
WIMS	296522	450	120	--	255	2004	Domestic	--	Ozark Aquifer	20
WIMS	296526	410	120	--	265	2003	Domestic	--	Ozark Aquifer	25
WIMS	304234	--	--	--	220	2010	Domestic	--	Ozark Aquifer	--
WIMS	321157	410	170	--	235	2003	Domestic	--	Ozark Aquifer	25
WIMS	326618	390	150	--	235	2003	Domestic	--	Ozark Aquifer	25
WIMS	326623	230	80	--	105	2003	Domestic	--	Ozark Aquifer	20
WIMS	326624	235	140	--	--	2003	Domestic	--	Ozark Aquifer	30
WIMS	326625	430	143	--	245	2003	Domestic	--	Ozark Aquifer	25
WIMS	326655	395	104	--	245	2003	Domestic	--	Ozark Aquifer	25
WIMS	355288	480	80	--	261	2005	Domestic	--	Ozark Aquifer	35
WIMS	379299	380	80	--	160	2006	Domestic	--	Ozark Aquifer	35
WIMS	441754	485	102	--	300	2009	Domestic	--	Ozark Aquifer	20

Wells found within 0.5 to 1 mile of the site: 20

1 to 2 Miles

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
PDWP	104064	1000	425	--	--	1997	Community Public	Seven Trails West Subd.	Ozark Aquifer	--
PDWP	104349	1015	440	1070	320	2001	Community Public	Camden Co. PWSD #2	Ozark Aquifer	300
WIMS	1841	380	305	--	225	1987	Domestic	--	Ozark Aquifer	30
WIMS	4796	302	84	--	150	1987	Domestic	--	Ozark Aquifer	25
WIMS	7297	440	210	--	320	1988	Domestic	--	Ozark Aquifer	30
WIMS	15206	343	103	--	140	1989	Domestic	--	Ozark Aquifer	25
WIMS	46872	231	125	--	110	1991	Domestic	--	Ozark Aquifer	30
WIMS	46895	377	119	--	205	1993	Domestic	--	Ozark Aquifer	25
WIMS	52619	210	130	--	75	1991	Domestic	--	Ozark Aquifer	25
WIMS	52621	291	100	--	100	1991	Domestic	--	Ozark Aquifer	25
WIMS	52638	290	80	--	105	1992	Domestic	--	Ozark Aquifer	20
WIMS	57052	251	100	--	110	1991	Domestic	--	Ozark Aquifer	25
WIMS	77411	310	80	--	97	1992	Domestic	--	Ozark Aquifer	40
WIMS	82507	260	170	--	147	1992	Domestic	--	Ozark Aquifer	40
WIMS	84617	440	115	990	207	1992	Domestic	--	Ozark Aquifer	50
WIMS	100968	460	167	--	196	1994	Domestic	--	Ozark Aquifer	15
WIMS	127262	340	185	--	--	1994	Domestic	--	Ozark Aquifer	--
WIMS	158056	410	157	1030	220	1997	Domestic	--	Ozark Aquifer	25
WIMS	189065	353	100	--	240	1997	Domestic	--	Ozark Aquifer	--
WIMS	189074	415	100	--	195	1997	Domestic	--	Ozark Aquifer	35
WIMS	189084	310	173	--	153	1997	Domestic	--	Ozark Aquifer	--
WIMS	189092	291	147	960	155	1998	Domestic	--	Ozark Aquifer	25
WIMS	210491	400	159	1000	210	1998	Domestic	--	Ozark Aquifer	40
WIMS	221967	340	100	1000	210	2000	Domestic	--	Ozark Aquifer	35
WIMS	228722	300	120	930	180	1999	Domestic	--	Ozark Aquifer	40
WIMS	247527	405	--	--	250	2006	Domestic	--	Ozark Aquifer	--
WIMS	253298	560	252	1080	340	2001	Domestic	--	Ozark Aquifer	60
WIMS	255063	400	100	--	200	2000	Domestic	--	Ozark Aquifer	35
WIMS	263102	497	100	--	340	2001	Domestic	--	Ozark Aquifer	25
WIMS	263726	426	80	950	268	2001	Domestic	--	Ozark Aquifer	35
WIMS	278448	230	80	--	--	2002	Domestic	--	Ozark Aquifer	20
WIMS	293102	380	100	--	103	2002	Domestic	--	Ozark Aquifer	55
WIMS	310109	340	160	920	172	2005	Domestic	--	Ozark Aquifer	30
WIMS	310184	360	140	920	160	2003	Domestic	--	Ozark Aquifer	30
WIMS	321693	460	160	1060	252	2003	Domestic	--	Ozark Aquifer	30
WIMS	334823	305	81	920	160	2005	Domestic	--	Ozark Aquifer	25
WIMS	376990	487	81	--	260	2006	Domestic	--	Ozark Aquifer	30
WIMS	376995	405	81	--	260	2006	Domestic	--	Ozark Aquifer	45
WIMS	433554	300	120	--	125	2008	Domestic	--	Ozark Aquifer	60
WIMS	433579	480	160	--	332	2009	Domestic	--	Ozark Aquifer	20
WIMS	433982	485	102	--	300	2009	Domestic	--	Ozark Aquifer	25
WIMS	446162	580	115	--	200	2010	Domestic	--	Ozark Aquifer	35
WIMS	447257	465	103	--	218	2010	Domestic	--	Ozark Aquifer	20
WIMS	473508	520	200	--	312	2012	Domestic	--	Ozark Aquifer	40

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
WIMS	491511	575	95	--	260	2014	Domestic	--	Ozark Aquifer	35
WIMS	492193	260	120	--	140	2015	Domestic	--	Ozark Aquifer	40
WIMS	518734	420	180	--	270	2016	Domestic	--	Ozark Aquifer	30
Logmain	20374	345	--	1104	200	--	Domestic	Ward	Ozark Aquifer	--

Wells found within 1 to 2 miles of the site: 48

2 to 3 Miles

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
PDWP	103794	550	350	--	175	1970	Community Public	Southway Terrace MHP	Ozark Aquifer	--
PDWP	103982	--	--	--	--	--	Community Public	Country Meadows Estates	Ozark Aquifer	--
PDWP	105450	--	--	--	--	--	Community Public	Hickory Village	Ozark Aquifer	--
PDWP	105998	--	--	--	--	--	Community Public	Timberlake Terrace	Ozark Aquifer	--
WIMS	2249	420	147	--	215	1987	Domestic	--	Ozark Aquifer	30
WIMS	3673	200	84	--	100	1987	Domestic	--	Ozark Aquifer	20
WIMS	4049	445	105	--	--	1987	Domestic	--	Ozark Aquifer	30
WIMS	4060	400	105	--	200	1987	Domestic	--	Ozark Aquifer	30
WIMS	5179	280	84	--	145	1988	Domestic	--	Ozark Aquifer	30
WIMS	8719	400	181	--	155	1988	Domestic	--	Ozark Aquifer	30
WIMS	11489	400	106	--	160	1988	Domestic	--	Ozark Aquifer	25
WIMS	12040	385	83	--	200	1988	Domestic	--	Ozark Aquifer	37
WIMS	15369	315	--	--	--	1989	Domestic	--	Ozark Aquifer	--
WIMS	16078	295	85	--	140	1989	Domestic	--	Ozark Aquifer	20
WIMS	17000	191	80	--	70	1989	Domestic	--	Ozark Aquifer	37
WIMS	35888	333	121	--	210	1991	Domestic	--	Ozark Aquifer	20
WIMS	44602	380	139	--	205	1989	Domestic	--	Ozark Aquifer	25
WIMS	58354	360	126	--	205	1990	Domestic	--	Ozark Aquifer	20
WIMS	59132	233	80	--	55	1993	Domestic	--	Ozark Aquifer	35
WIMS	77414	310	100	--	150	1993	Domestic	--	Ozark Aquifer	22
WIMS	120299	280	--	--	--	1994	Domestic	--	Ozark Aquifer	--
WIMS	120860	352	80	--	170	1994	Domestic	--	Ozark Aquifer	20
WIMS	120871	210	90	--	70	1994	Domestic	--	Ozark Aquifer	25
WIMS	138032	333	107	954	165	1995	Domestic	--	Ozark Aquifer	30
WIMS	138037	350	100	--	145	1995	Domestic	--	Ozark Aquifer	20
WIMS	138043	310	80	--	110	1997	Domestic	--	Ozark Aquifer	20
WIMS	138052	291	80	--	105	1995	Domestic	--	Ozark Aquifer	20
WIMS	138057	433	120	--	315	1996	Domestic	--	Ozark Aquifer	30
WIMS	138062	333	108	--	--	1995	Domestic	--	Ozark Aquifer	25
WIMS	138070	250	80	--	70	1996	Domestic	--	Ozark Aquifer	20
WIMS	138072	291	80	--	90	1996	Domestic	--	Ozark Aquifer	20
WIMS	138076	270	80	--	90	1996	Domestic	--	Ozark Aquifer	20
WIMS	138081	310	80	--	145	1996	Domestic	--	Ozark Aquifer	20
WIMS	138086	350	110	--	155	1996	Domestic	--	Ozark Aquifer	18
WIMS	148329	415	100	--	150	1996	Domestic	--	Ozark Aquifer	50
WIMS	173793	430	142	--	260	1996	Domestic	--	Ozark Aquifer	50

Water wells located within 4 miles of Camdenton Sludge Disposal site.

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
WIMS	182567	220	100	940	92	1998	Domestic	--	Ozark Aquifer	40
WIMS	186117	380	184	--	140	1998	Domestic	--	Ozark Aquifer	30
WIMS	189073	370	110	--	210	1997	Domestic	--	Ozark Aquifer	20
WIMS	189079	250	80	--	105	1997	Domestic	--	Ozark Aquifer	20
WIMS	189080	290	80	--	90	1998	Domestic	--	Ozark Aquifer	25
WIMS	209888	280	100	--	150	2000	Domestic	--	Ozark Aquifer	25
WIMS	213437	609	122	--	400	1999	Domestic	--	Ozark Aquifer	20
WIMS	213457	220	82	--	100	1999	Domestic	--	Ozark Aquifer	15
WIMS	214483	375	100	--	205	1999	Domestic	--	Ozark Aquifer	30
WIMS	214512	290	80	--	105	1999	Domestic	--	Ozark Aquifer	30
WIMS	217587	333	142	--	120	1997	Domestic	--	Ozark Aquifer	15
WIMS	221966	400	120	1080	--	2000	Domestic	--	Ozark Aquifer	35
WIMS	236451	270	80	--	135	1998	Domestic	--	Ozark Aquifer	25
WIMS	251146	440	140	1080	--	2000	Domestic	--	Ozark Aquifer	25
WIMS	252739	380	242	1000	230	2000	Domestic	--	Ozark Aquifer	30
WIMS	252914	440	180	1020	250	2002	Domestic	--	Ozark Aquifer	28
WIMS	255051	450	100	--	220	2000	Domestic	--	Ozark Aquifer	40
WIMS	255974	390	80	--	155	2000	Domestic	--	Ozark Aquifer	30
WIMS	256057	210	80	--	55	2000	Domestic	--	Ozark Aquifer	30
WIMS	256367	250	92	--	105	2000	Domestic	--	Ozark Aquifer	30
WIMS	256370	230	84	--	110	1999	Domestic	--	Ozark Aquifer	30
WIMS	256377	230	100	--	105	--	Domestic	--	Ozark Aquifer	30
WIMS	263087	375	80	--	145	2000	Domestic	--	Ozark Aquifer	18
WIMS	263098	290	80	--	135	2001	Domestic	--	Ozark Aquifer	25
WIMS	272250	300	100	--	120	2001	Domestic	--	Ozark Aquifer	35
WIMS	272255	280	80	900	140	2001	Domestic	--	Ozark Aquifer	35
WIMS	274492	400	160	1000	255	2001	Domestic	--	Ozark Aquifer	30
WIMS	278442	350	90	--	195	2002	Domestic	--	Ozark Aquifer	25
WIMS	278455	270	119	--	70	2002	Domestic	--	Ozark Aquifer	25
WIMS	278458	370	110	--	200	2002	Domestic	--	Ozark Aquifer	20
WIMS	282983	340	80	--	180	2001	Domestic	--	Ozark Aquifer	25
WIMS	282996	400	80	900	172	2001	Domestic	--	Ozark Aquifer	50
WIMS	288265	230	109	--	109	2003	Domestic	--	Ozark Aquifer	35
WIMS	293085	445	80	--	273	2006	Domestic	--	Ozark Aquifer	35
WIMS	309062	420	100	--	181	2003	Domestic	--	Ozark Aquifer	35
WIMS	309083	460	80	--	198	2003	Domestic	--	Ozark Aquifer	45
WIMS	321093	395	100	--	180	2003	Domestic	--	Ozark Aquifer	35
WIMS	321160	310	120	--	109	2003	Domestic	--	Ozark Aquifer	25
WIMS	321163	370	110	--	165	2003	Domestic	--	Ozark Aquifer	20
WIMS	321165	310	100	--	109	2003	Domestic	--	Ozark Aquifer	25
WIMS	321233	325	80	--	43	2004	Domestic	--	Ozark Aquifer	35
WIMS	321252	500	100	--	328	2004	Domestic	--	Ozark Aquifer	35
WIMS	321656	340	120	900	179	2003	Domestic	--	Ozark Aquifer	30
WIMS	327008	440	120	--	198	2004	Domestic	--	Ozark Aquifer	30

Water wells located within 4 miles of Camdenton Sludge Disposal site.

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
WIMS	330307	285	81	880	160	2004	Domestic	--	Ozark Aquifer	35
WIMS	338702	400	80	--	88	2004	Domestic	--	Ozark Aquifer	35
WIMS	347066	290	80	--	150	2005	Domestic	--	Ozark Aquifer	35
WIMS	349615	600	120	--	250	2005	Domestic	--	Ozark Aquifer	35
WIMS	355292	420	80	--	160	2005	Domestic	--	Ozark Aquifer	65
WIMS	368189	400	160	--	185	2006	Domestic	--	Ozark Aquifer	30
WIMS	368921	330	80	--	131	2006	Domestic	--	Ozark Aquifer	40
WIMS	369247	247	181	--	95	2006	Domestic	--	Ozark Aquifer	70
WIMS	375750	446	81	--	300	2005	Domestic	--	Ozark Aquifer	25
WIMS	379284	370	80	--	160	2006	Domestic	--	Ozark Aquifer	60
WIMS	380347	287	101	--	120	2006	Domestic	--	Ozark Aquifer	30
WIMS	380348	287	121	--	120	2006	Domestic	--	Ozark Aquifer	30
WIMS	394002	390	100	--	188	2006	Domestic	--	Ozark Aquifer	60
WIMS	394003	270	80	--	100	2006	Domestic	--	Ozark Aquifer	40
WIMS	394892	260	80	--	86	2006	Domestic	--	Ozark Aquifer	50
WIMS	402889	407	121	--	90	2007	Domestic	--	Ozark Aquifer	40
WIMS	441778	365	122	--	180	2009	Domestic	--	Ozark Aquifer	30
WIMS	441943	365	83	--	160	2010	Domestic	--	Ozark Aquifer	30
WIMS	447228	405	105	--	160	2011	Domestic	--	Ozark Aquifer	50
WIMS	459941	225	83	--	80	2012	Domestic	--	Ozark Aquifer	50
WIMS	479295	340	100	--	98	2013	Domestic	--	Ozark Aquifer	60
WIMS	479301	400	100	--	85	2013	Domestic	--	Ozark Aquifer	30
WIMS	492198	400	140	--	252	2015	Domestic	--	Ozark Aquifer	20
WIMS	495133	420	100	--	200	2015	Domestic	--	Ozark Aquifer	30
WIMS	505882	255	100	--	60	2016	Domestic	--	Ozark Aquifer	35
WIMS	519555	315	90	--	70	2016	Domestic	--	Ozark Aquifer	35
Logmain	2649	367	--	1065	--	1932	Domestic	Collins	Ozark Aquifer	--
Logmain	13462	275	--	1065	225	1955	Domestic	Chandler	Ozark Aquifer	--

Wells found within 2 to 3 miles of the site: 108

3 to 4 Miles

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
PDWP	103792	940	450	--	254	1961	Municipal	Camdenton	Ozark Aquifer	380
PDWP	104791	1100	425	1103	285	1995	Community Public	Camden Co. PWSD #2	Ozark Aquifer	350
PDWP	105312	500	301	803	45	--	Non-community Public	Deer Chase Golf	Ozark Aquifer	100
PDWP	105928	--	--	--	--	--	Community Public	Green Acres MHP	Ozark Aquifer	--
PDWP	106319	--	--	--	--	--	Community Public	J Bar H Estates	Ozark Aquifer	--
PDWP	106605	1500	425	1025	285	2011	Community Public	Camdenton	Ozark Aquifer	500
WIMS	2067	360	126	--	220	1987	Domestic	--	Ozark Aquifer	30
WIMS	4048	427	106	--	235	1987	Domestic	--	Ozark Aquifer	25
WIMS	6681	460	90	--	245	1987	Domestic	--	Ozark Aquifer	15
WIMS	7295	380	126	--	270	1988	Domestic	--	Ozark Aquifer	40
WIMS	8720	300	121	--	145	1988	Domestic	--	Ozark Aquifer	25
WIMS	14809	320	--	--	--	1989	Domestic	--	Ozark Aquifer	--

Water wells located within 4 miles of Camdenton Sludge Disposal site.

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
WIMS	16083	251	86	--	--	1989	Domestic	--	Ozark Aquifer	30
WIMS	18569	210	110	--	100	1994	Domestic	--	Ozark Aquifer	20
WIMS	24538	380	140	945	208	2005	Domestic	--	Ozark Aquifer	20
WIMS	24547	380	180	--	189	2005	Domestic	--	Ozark Aquifer	60
WIMS	26775	467	126	--	210	1989	Domestic	--	Ozark Aquifer	60
WIMS	52598	312	100	--	155	1992	Domestic	--	Ozark Aquifer	25
WIMS	52647	268	80	--	140	1992	Domestic	--	Ozark Aquifer	30
WIMS	52655	208	80	--	95	1992	Domestic	--	Ozark Aquifer	20
WIMS	54161	340	106	--	166	1990	Domestic	--	Ozark Aquifer	22
WIMS	54295	300	100	--	85	1990	Domestic	--	Ozark Aquifer	45
WIMS	62718	200	100	--	12	1991	Domestic	--	Ozark Aquifer	60
WIMS	62738	260	192	--	150	1991	Domestic	--	Ozark Aquifer	20
WIMS	62774	360	144	--	205	1991	Domestic	--	Ozark Aquifer	30
WIMS	77413	251	150	--	100	1993	Domestic	--	Ozark Aquifer	20
WIMS	77419	360	80	--	210	1992	Domestic	--	Ozark Aquifer	40
WIMS	77420	370	80	--	195	1992	Domestic	--	Ozark Aquifer	20
WIMS	84592	205	143	787	55	1992	Domestic	--	Ozark Aquifer	25
WIMS	98871	304	80	935	100	1994	Domestic	--	Ozark Aquifer	28
WIMS	120851	456	110	--	295	1994	Domestic	--	Ozark Aquifer	15
WIMS	120859	253	100	--	115	1994	Domestic	--	Ozark Aquifer	20
WIMS	138031	351	100	--	155	1995	Domestic	--	Ozark Aquifer	25
WIMS	138060	380	80	970	240	1996	Domestic	--	Ozark Aquifer	20
WIMS	138069	371	105	--	170	1996	Domestic	--	Ozark Aquifer	25
WIMS	141774	395	100	--	210	1995	Domestic	--	Ozark Aquifer	40
WIMS	141775	350	--	--	--	1995	Domestic	--	Ozark Aquifer	--
WIMS	148588	320	104	--	110	1995	Domestic	--	Ozark Aquifer	40
WIMS	154603	300	100	--	110	1996	Domestic	--	Ozark Aquifer	30
WIMS	154622	420	120	--	45	1996	Domestic	--	Ozark Aquifer	40
WIMS	154630	178	100	768	--	1996	Domestic	--	Ozark Aquifer	60
WIMS	157741	190	82	866	30	1997	Domestic	--	Ozark Aquifer	20
WIMS	189055	475	126	--	318	1997	Domestic	--	Ozark Aquifer	25
WIMS	189086	290	80	980	145	1997	Domestic	--	Ozark Aquifer	20
WIMS	189088	350	80	945	--	1997	Domestic	--	Ozark Aquifer	25
WIMS	190871	280	82	--	100	1997	Domestic	--	Ozark Aquifer	25
WIMS	209957	320	105	1080	115	1998	Domestic	--	Ozark Aquifer	45
WIMS	214490	330	100	950	195	1999	Domestic	--	Ozark Aquifer	25
WIMS	214495	270	80	--	135	1999	Domestic	--	Ozark Aquifer	20
WIMS	217592	190	140	--	90	1998	Domestic	--	Ozark Aquifer	18
WIMS	217596	270	80	1040	145	1998	Domestic	--	Ozark Aquifer	20
WIMS	217600	190	84	--	30	1998	Domestic	--	Ozark Aquifer	25
WIMS	217602	190	80	--	25	1998	Domestic	--	Ozark Aquifer	25
WIMS	217613	395	103	--	265	1998	Domestic	--	Ozark Aquifer	20
WIMS	217620	250	190	--	--	1998	Domestic	--	Ozark Aquifer	25
WIMS	226748	360	100	--	--	2000	Domestic	--	Ozark Aquifer	35

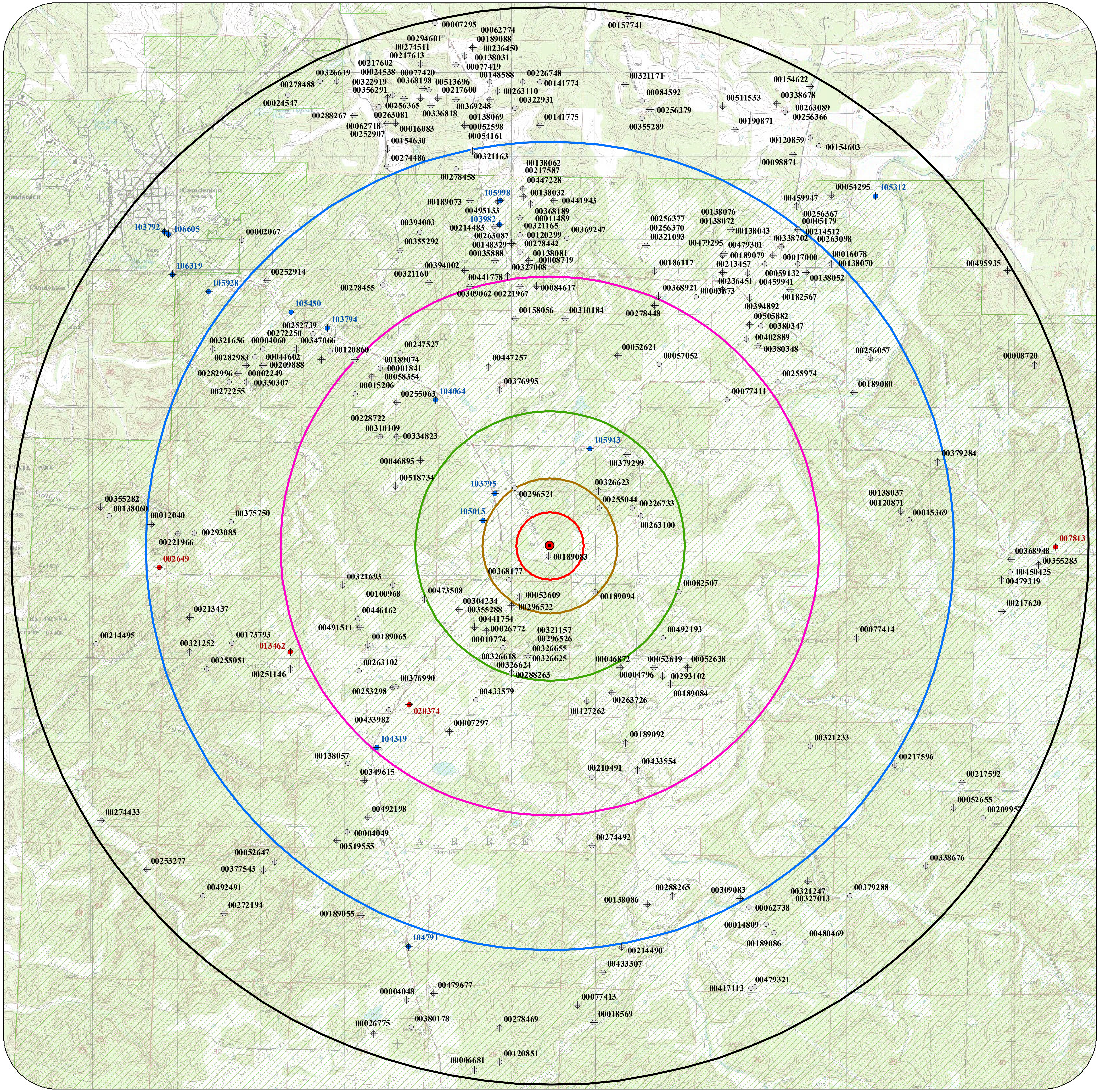
Water wells located within 4 miles of Camdenton Sludge Disposal site.

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
WIMS	236450	370	100	--	220	1998	Domestic	--	Ozark Aquifer	25
WIMS	252907	380	140	964	252	2001	Domestic	--	Ozark Aquifer	40
WIMS	253277	180	100	780	--	2000	Domestic	--	Ozark Aquifer	25
WIMS	256365	190	80	--	20	2000	Domestic	--	Ozark Aquifer	30
WIMS	256366	270	80	--	145	2000	Domestic	--	Ozark Aquifer	20
WIMS	256379	230	80	--	36	2000	Domestic	--	Ozark Aquifer	--
WIMS	263081	370	92	--	230	2001	Domestic	--	Ozark Aquifer	25
WIMS	263089	230	80	--	20	2001	Domestic	--	Ozark Aquifer	30
WIMS	263110	370	80	--	188	2002	Domestic	--	Ozark Aquifer	25
WIMS	272194	330	85	--	140	2001	Domestic	--	Ozark Aquifer	30
WIMS	274433	200	100	760	2	2002	Domestic	--	Ozark Aquifer	20
WIMS	274486	180	100	787	6	2002	Domestic	--	Ozark Aquifer	30
WIMS	274511	400	140	925	248	2001	Domestic	--	Ozark Aquifer	30
WIMS	278469	410	--	1140	--	2001	Domestic	--	Ozark Aquifer	--
WIMS	278488	230	80	--	45	2001	Domestic	--	Ozark Aquifer	25
WIMS	288267	270	106	--	145	2003	Domestic	--	Ozark Aquifer	25
WIMS	294601	425	122	925	260	2002	Domestic	--	Ozark Aquifer	49
WIMS	321171	280	80	--	93	2003	Domestic	--	Ozark Aquifer	20
WIMS	321247	270	80	--	133	2003	Domestic	--	Ozark Aquifer	25
WIMS	322919	375	100	--	200	2003	Domestic	--	Ozark Aquifer	35
WIMS	322931	395	100	--	--	2003	Domestic	--	Ozark Aquifer	25
WIMS	326619	190	80	--	55	2003	Domestic	--	Ozark Aquifer	20
WIMS	327013	400	126	--	144	2003	Domestic	--	Ozark Aquifer	35
WIMS	336818	400	80	--	231	2004	Domestic	--	Ozark Aquifer	35
WIMS	338676	240	80	--	119	2004	Domestic	--	Ozark Aquifer	25
WIMS	338678	340	80	--	118	2004	Domestic	--	Ozark Aquifer	40
WIMS	355282	500	80	--	267	2005	Domestic	--	Ozark Aquifer	35
WIMS	355283	320	80	--	128	2005	Domestic	--	Ozark Aquifer	30
WIMS	355289	180	80	--	51	2005	Domestic	--	Ozark Aquifer	30
WIMS	356291	360	160	--	238	2005	Domestic	--	Ozark Aquifer	30
WIMS	368198	380	160	--	190	2006	Domestic	--	Ozark Aquifer	20
WIMS	368948	330	80	--	180	2006	Domestic	--	Ozark Aquifer	40
WIMS	369248	467	161	--	245	2006	Domestic	--	Ozark Aquifer	30
WIMS	377543	507	81	--	320	2006	Domestic	--	Ozark Aquifer	40
WIMS	379288	170	80	--	10	2006	Domestic	--	Ozark Aquifer	50
WIMS	380178	565	130	--	330	2007	Domestic	--	Ozark Aquifer	20
WIMS	417113	405	81	--	200	2007	Domestic	--	Ozark Aquifer	30
WIMS	433307	420	105	1010	150	2009	Domestic	--	Ozark Aquifer	40
WIMS	450425	340	100	--	140	2012	Domestic	--	Ozark Aquifer	30
WIMS	459947	305	82	--	120	2012	Domestic	--	Ozark Aquifer	35
WIMS	479319	380	120	--	138	2013	Domestic	--	Ozark Aquifer	30
WIMS	479321	380	120	--	180	2013	Domestic	--	Ozark Aquifer	30
WIMS	479677	505	83	--	140	2013	Domestic	--	Ozark Aquifer	25
WIMS	480469	440	104	--	120	2013	Domestic	--	Ozark Aquifer	20

Water wells located within 4 miles of Camdenton Sludge Disposal site.

Source	Well ID	Depth	Casing	Elev.	SWL	Date	Use	Owner	Geohydrologic Unit	Yield
WIMS	492491	365	83	--	220	2015	Domestic	--	Ozark Aquifer	25
WIMS	495935	355	90	--	120	2016	Domestic	--	Ozark Aquifer	25
WIMS	511533	305	83	--	70	2016	Domestic	--	Ozark Aquifer	30
WIMS	513696	465	83	--	180	2016	Domestic	--	Ozark Aquifer	30
Logmain	7813	156	--	1052	76	1942	Domestic	Phellips	Ozark Aquifer	--

Wells found within 3 to 4 miles of the site: 105

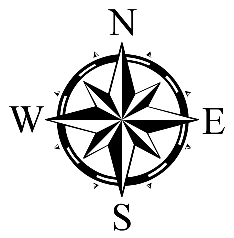


1 0.5 0 1 2 3 4 5 6 7 Miles

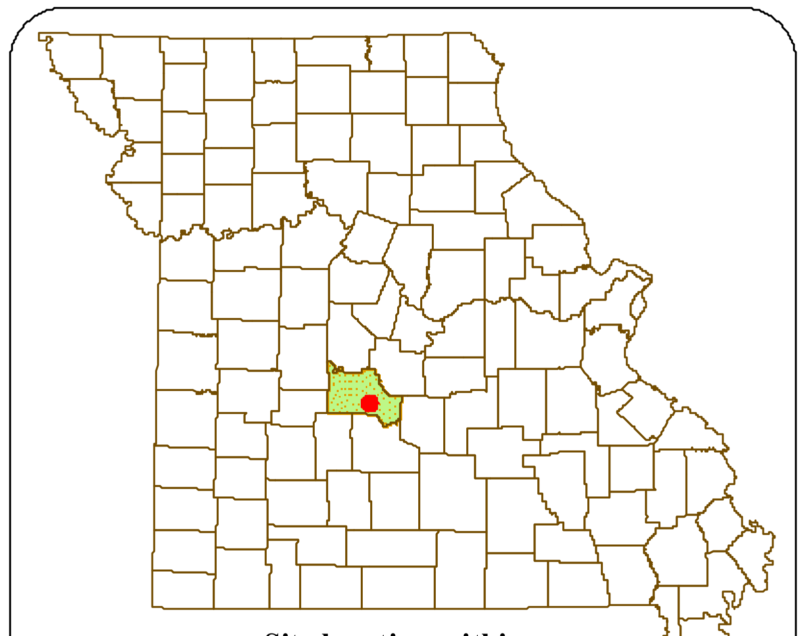
Figure 2:
Four-Mile Well Survey
Camdenton Sludge Disposal Site
Camden County, Missouri
September 12, 2017

Target Limits

- 0.25 Mile
- 0.5 Mile
- 1 Mile
- 2 Mile
- 3 Mile
- 4 Mile



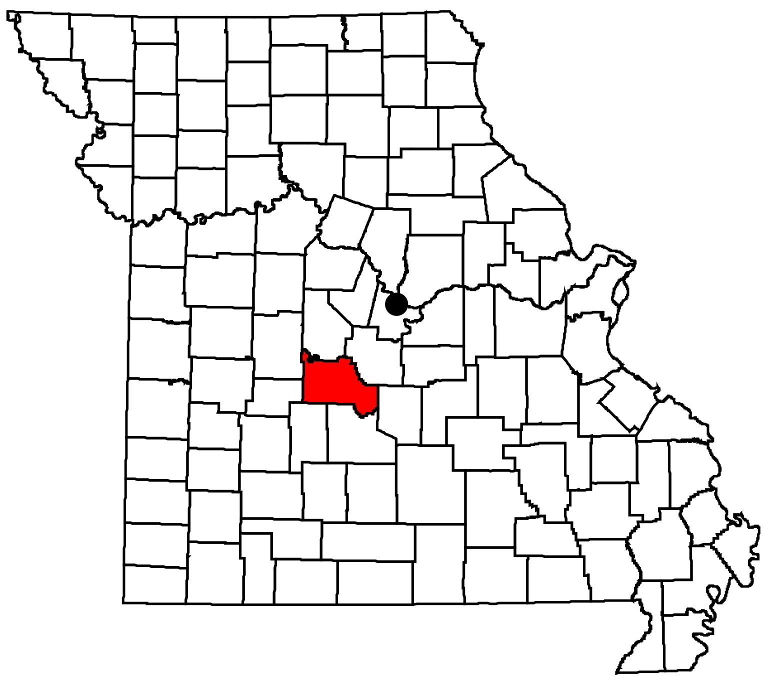
- Camdenton Sludge Disposal site
- Well from Public Drinking Water Program
- Certified well from the Well Information Management System (WIMS)
- Well from MDNR/MGS sample well-log library (Logmain)
- Municipal and county public water supply districts



Site location within
Camden County, Missouri

SITE REASSESSMENT SAMPLING AND ANALYSIS PLAN

Camdenton Sludge Disposal Area
Camden County, Missouri
September 28, 2017



MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

Prepared By:

Missouri Department of Natural Resources
Division of Environmental Quality
Hazardous Waste and Environmental Services Programs

Table of Contents

1.0 Introduction

As authorized under the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986, the Missouri Department of Natural Resources (Department), Hazardous Waste Program (HWP), Site Assessment Unit (SAU) is conducting a Site Reassessment (SR) at the Camdenton Sludge Disposal Area site. The Camdenton Sludge Disposal Area is the location of a disposal site for municipal sewage sludge that contained industrial effluent and is suspected to contain contaminants that could be released into the environment.

The objective of this investigation is to re-assess potential threats to human health and the environment at the site. The investigation will include collection of groundwater samples from private and public drinking water wells in the vicinity of the former Camdenton Sludge Disposal area at the Camdenton Municipal Airport.

2.0 Site Information

2.1 Location

The Camdenton Sludge Disposal Area site is located on Old South 5 in the southeast portion of the Camdenton Memorial Airport property. The site is located on city property, but is actually three miles southeast of Camdenton city limits (Figure 1). The latitude and longitude for the site are 37.968892 and -92.687353. The sludge disposal area has been previously identified at the south east side of the airport and a portion of the original area has since been covered by pavement during an expansion of the runway. The site is approximately four miles from three other sites in Camdenton with known soil and groundwater Trichloroethylene (TCE) contamination; Hulett Lagoon (where the sludge originated), former Modine Manufacturing facility and the City of Camdenton’s Mulberry Well.

2.2 Operational and Site History

The site is a municipal airport for the City of Camdenton. The full name of the airport is the Camdenton Memorial –Lake Regional Airport (KOZS). Regional flights serve the Lake of the Ozarks regional area. In 1989 the City of Camdenton land applied sewage sludge from Hulett Lagoon which received industrial effluent from a metal parts manufacturing facility. The waters and sludge from Hulett Lagoon have been found to contain VOCs and metals. The sludge was applied to an area at the south end of the airport south and east of the runway. The disposal and application of Hulett Lagoon sludge at the airport and subsequent investigations are discussed below.

2.3 Previous Investigations

The department's Superfund site assessment unit completed a Combined Preliminary Assessment/Site Inspection (PA/SI) Report on the Camdenton Sludge Disposal Area site on March 30, 1999 (MDNR, 1999). Soil borings were collected in the sludge disposal area of the airport. Total chromium, copper, lead and nickel were detected above background concentrations in the soil borings collected within the sludge material, but no TCE was detected in any of the soil cores. Only the total chromium levels exceeded the Superfund Chemical Data Matrix (SCDM) benchmarks. No hexavalent chromium analysis was conducted. None of the soil samples were characterized as characteristically hazardous waste using the Toxicity Characteristic Leaching Procedure (TCLP). Ethylbenzene, toluene, and total xylenes were detected in soil sores at concentrations above background levels but below health based benchmarks.

Groundwater samples were also collected from private and public drinking water wells in the area. Although there was an initial positive detection of 20 micrograms per liter (ug/L) and 21 ug/L TCE in a pair of groundwater samples from two private wells near the disposal site,

repeated sampling efforts were unable to duplicate these results and it was determined that there was no significant threat from TCE in the groundwater at that time (Table 1). Barium and copper were detected in the groundwater samples but not at levels significantly above background for those elements. Lead was detected at a concentration of 17.1 ug/L at one private well, which exceeds the Maximum Contaminant Level (MCL) of 15 ug/L lead allowable in public drinking water systems. Another private well had lead detected at 4.9 ug/L which is below the MCL

Table 1: Previous Groundwater Sample Results from Nearby Wells (MDNR, 1999)

Element/Compound	3496 RR3 Concentration (ug/L)	3499 RR3 Concentration (ug/L)	National Drinking Water Standards – Maximum Contaminant Levels (ug/L)
Metals- total recoverable			
Barium	81.7	46.4	2000
Copper	12.8	54.1	1300
Lead	17.7	4.9	15
VOCs			
Trichloroethylene	ND	ND	5
1,2-Dichloroethylene	ND	ND	70

3.0 Data Quality Objectives

To help ensure precise, accurate, representative, complete, and comparable data, all field work and analyses will be conducted in accordance with the Quality Assurance Project Plan (QAPP) for Pre-Remedial/Pre-Removal and Targeted Brownfields Site Assessments Revision 7, December 7, 2012, and ongoing (MDNR, 2012). The QAPP describes the general data quality objectives (DQO) for site assessment investigations conducted by the HWP and ESP. Those DQOs specific to this project are described below.

3.1 Problem Statement

Although the site was previously investigated in the 1999 PA/SI, it is currently unknown whether contaminants may have migrated into local groundwater. Additionally, the sludge disposal area has been disturbed during airport improvement activities conducted after the 1999 PA/SI assessment, and citizens have become concerned that the extension of the runways may have released contaminants that were meant to remain buried. Residents near the airport obtain drinking water from private wells and there is concern about potential impact to groundwater from the site.

3.2 Planning Team

The planning team includes staff from the HWP Superfund Section, EPA Region 7, ESP Field Services and Chemical Analysis Sections, and the Missouri Geological Survey.

3.3 Conceptual Site Model

<u>Contaminant Release</u>

Sewage sludge containing hazardous constituents was land applied in a department permitted action by City of Camdenton employees and contractors in 1989. Prior to transport the sewage sludge from Hulett Lagoon was dewatered and some mixing with neighboring soils occurred. During application at the Camdenton Municipal Airport sludge was land applied and mixed with native soils during application. After application the surface soils were treated with lime to raise the pH to immobilize metals. The sludge from Hulett Lagoon had previously shown to contain, TCE, copper, chromium, cadmium, lead, and other metals (MDNR, 1999). Although the permit for disposal required disking and mixing of the sludge with native soils, they encountered difficulty in drying out the materials and at least some portion of the sludge was evidently applied unmixed into a low lying area on site.

Previous investigation by the department documented soil concentrations above background levels for the following contaminants: chromium; copper, lead, mercury, nickel, selenium, silver, ethylbenzene, toluene and total xylenes (Table 2). Chromium was the only contaminant detected in surface soils on site at levels exceeding the Superfund Chemical Data Matrix (SCDM) indexes (MDNR, 1999).

TCE was not detected in any of the surface soil samples during the PA/SI and no shallow groundwater was encountered after advancing a hydraulic probe to refusal. However, it is possible that any residual TCE in the surface soils had already passed into the deeper groundwater considering the karstic environment and the fact that a decade had passed between the application of the sludge and the PA/SI sampling. It is also likely that the excavation, drying, hauling, disking and grading of the Hulett Lagoon sludge resulted in a large portion of the remaining TCE evaporating into the atmosphere during land application.

TABLE 2: SELECTED ANALYTICAL RESULTS FROM SOIL SAMPLES COLLECTED IN/NEAR THE CAMDENDTON SLUDGE DISPOSAL AREA, 1999

All results in parts per million (ppm) * soil saturation level substituted for ASL NA - not analyzed NL - not listed
Underlined results are those that are three times above background or above the detection limit if the background concentration is below the detection limit
Bolded results are those that are above background and exceed SCDM Benchmark and/or MO ASL

	Hulett-11	Hulett-12		Hulett-17	Hulett-18	Hulett-19			Hulett-20		SCDM Bnchmrk	MO ASL	MO CALM C_{LEACH}
	0.5' – 1'	0.5' – 1'	8.5' – 9'	0.5' – 1.5'	5.5' – 6'	0.5' – 1'	7' – 7.5'	7' – 7.5'	0.5' – 1'	5.5' – 6'			
	991476 stockpile	991478 sludge	991477	991479	991480	991483 sludge	991481	991482 replicate	991484 background	991485			
METALS													
Arsenic, total	7.46	8.78	4.98	5.97	7.08	19.7	4.94	5.76	8.74	34	0.0043	11	NL
Barium, total	170	280	139	105	93.7	253	69	82.6	206	195	5500	3900	1650
Cadmium, total	<0.2	0.782	<0.2	<0.2	0.216	1.55	<0.2	<0.2	<0.2	0.409	39	28	11
Chromium, total	33.1	**1640**	27.5	34.7	74.8	**7830**	38.8	43.9	38.1	110	390	5600	38
Chromium, TCLP	NA	0.0463	NA	NA	NA	0.041	NA	NA	NA	<0.004			
Copper, total	9.45	1890	10.4	6.79	7.12	11200	8.67	11.4	14.6	32	NL	NL	NL
Lead, total	21.8	66.2	19.2	17.3	19.4	121	13.5	16.6	26.3	67.6	NL	240	NL
Lead, TCLP	NA	NA	NA	NA	NA	<0.0411	NA	NA	NA	NA			
Mercury, total	<0.04	0.314	<0.04	<0.04	<0.04	0.195	<0.04	<0.04	0.0819	<0.04	23	17	3.23
Nickel, total	12.3	29.9	15.5	11.4	9.33	129	8.4	9.4	15.5	42.7	1600	1100	170
Selenium, total	<1	<1	<1	<1	<1	1.03	<1	<1	<1	<1	390	280	4.37
Silver, total	<1	<1	<1	<1	<1	3.17	<1	<1	<1	<1	390	280	255
VOCs													
Ethylbenzene	<0.025	<0.025	<0.025	<0.025	<0.025	0.023	<0.025	0.018	<0.025	<0.025	58	340	0.097
Toluene	<0.025	<0.025	<0.025	<0.025	<0.025	0.03	<0.025	<0.025	<0.025	<0.025	58	340	0.097
Total Xylenes	<0.025	<0.025	<0.025	<0.025	<0.025	0.084	<0.025	<0.025	<0.025	<0.025	58	340	0.097

Subsurface Properties

Surface soils on site are comprised of 'Union' and 'Variton' series silt loams with slopes from 0-18% (USDA, 1994). These surface soils are located in a groundwater recharge area (Bachle, 2017a) and are not expected to be saturated, although portions of the 'Variton' soils may contain fragipans features that could slow infiltration after rainfall events. Soils and residuum on site extend for approximately 10 feet of depth before bedrock is encountered (Elfrink, 1999). Surface soils have been disturbed in the immediate vicinity of the Camdenton Sludge Disposal Area, primarily to reshape the landscape and provide a flat surface for the adjacent airport runways.

Ordovician aged Roubidoux formations lie below the surface soils on site. The highly weathered Roubidoux formation may be reduced to clayey residuum, sandstones and thin lenses of remaining carbonate rocks. Local wells are unlikely to source much groundwater from the thinly distributed Roubidoux layer, but it may contribute flows to deeper strata and could contain areas of perched groundwater. In the headwaters of Racetrack Hollow, approximately 1.5 miles northeast from the site, erosion has completely removed the Roubidoux formation and the underlying Gasconade formation is exposed at the surface. Because of this erosive potential, thicknesses of the Roubidoux formation are estimated as 0-90 feet depths in the site area (Elfrink, 1999).

Underlying the Roubidoux formation, the Gasconade Dolomite is comprised of cherty dolomite for approximately 280 feet. The Gunter Sandstone member is a 25 feet thick basal unit of the Gasconade dolomite that commonly separates the Ordovician and Cambrian-aged strata beneath the site.

The Cambrian aged strata below the site include the Eminence Dolomite (240-635 feet), the Potosi Dolomite (25-230 feet) and the Derby Doerun Dolomite and the shale-rich Davis formation which form the St. Francois confining unit. All units from the Roubidoux to the St. Francois confining unit comprise the Ozark aquifer (Table 3). The Bonneterre unit and Lamotte Sandstone form the St. Francois aquifer below the aquitard formed by the St. Francois confining unit and are unlikely to be contaminated (Elfrink, 1999).

The Ordovician-age Gasconade Dolomite and Roubidoux Formation directly underlying the site is part of the Ozark Aquifer. There are no known confining layers between the ground surface and the water table that would prevent migration of surface contaminants from reaching the Ozark aquifer at or near the location of the site. The bedrock below the site has substantial

secondary porosity development, or karst, as attested by the nearby classified losing stream segments, springs, caves, and 10- to 65-foot voids encountered when drilling local wells. The elevation of groundwater near the Camdenton Sludge Disposal site lies between 765 and 790 feet above mean sea level. Therefore, depths to groundwater beneath the site range from 230 to 295 feet bgs. Although karst features may influence groundwater flow directions in unpredictable ways, the general groundwater flow gradients move to the west and north from the site (Bachle, 2017a).

Given that TCE is heavier than water if it were released into the local portion of the Ozark Aquifer it would migrate downwards until reaching an impermeable layer such as the St. Francois confining unit (Elfrink, 1999). In addition to flowing downward with gravity, TCE would also be expected to move with the general direction of groundwater flow to the west and north of the site. The presence of karst features in the bedrock layers could further complicate the any future plume delineation activities with contaminants potentially migrating in unexpected directions (Bachle 2017a). Chromium and other metals would likely bind strongly to surface soil particles minimizing downward migration of these contaminants to that portion which is leached into solution with the groundwater. The liming of surface soils following the land application of the Hulett Lagoon sludge is expected to have enhanced the immobilization of metals near the surface (MDNR, 1999) , but concerns of metals leaching remain in areas where construction activities have disturbed surface soils. The alkaline chemistry of the underlying limestone bedrock layers is likely to further impede the migration of metals in groundwater.

Table 3: Stratigraphic Column for the Camdenton Sludge Disposal Area, Camden County (after Harvey et. al.,1983)

System	Aquifer Group	Approximate Site – Specific Thickness (ft)	Formation	Hydraulic Conductivity (cm/sec)	Regional Thickness (ft)	Dominant Lithology	Water-bearing Character
Quaternary		10	Colluvium and residuum		0-90	Regolith of residual clay, sand, chert pebbles and cobbles	May contain small amounts of perched water.
Ordovician	Ozark Aquifer	50	Roubidoux Formation	10^{-3}	0-90	Clayey residuum, sandstone and sandy dolomite	Not present in sufficient thickness in the Camdenton area to produce usable quantities of water.
		280	Gasconade Dolomite	10^{-6}	300-385	Cherty dolomite, minor sandstone, and shale	Yields moderate to large quantities of water to wells. Yields range from 20 to 75 gpm. Less-permeable Upper Gasconade may act as a leaky confining unit.
		25	Gunter Sandstone Member	10^{-4}	10-45	Sandstone	Contributes moderate to large quantities of water. Most wells open to other formations.
Cambrian		550?	Eminence Dolomite	10^{-5}	240-635	Cherty dolomite	Yields 6-100 gpm, the average being about 20 gpm
		50?	Potosi Dolomite	10^{-4}	30-330	Dolomite; contains abundant quartz druse	Yields large quantities of water to wells. Yields range from 100 to 750 gpm.
	St. Francois Confining Unit	80	Derby-Doerun Dolomite	10^{-7}	80?-215	Shaley dolomites and shale	Reliable aquitard.
		80	Davis Formation	10^{-7}	50-380?		
	St. Francois Aquifer	90	Bonneterre Formation	10^{-5}	85-200	Dolomite and limestone	Generally used only in outcrop areas. May contribute additional 100-200 gpm to wells open to other formations.
		300	Lamotte Sandstone	10^{-5}	140-300	Sandstone and arkosic conglomerate	
Precambrian	Basement Confining Unit					Igneous and metamorphic rocks	Does not yield water to wells in this area

Drinking Water

Residents of Camden County rural areas receive their drinking water from two primary sources; from Camden County Public Water District wells and wells sourced from the Ozark Aquifer on their property. An analysis by the Missouri Geological Survey (MGS) identified 287 drinking water wells located within four miles of the Camdenton sludge Disposal Site. Of these, 285 were private wells and two were for public drinking water systems. However, it is likely that there are additional wells beyond those described by MGS because their database only includes drinking water wells drilled after 1987 and some residents may be using older wells (Bachle, 2017b).

The City of Camdenton's Mulberry Well, located approximately 4 miles from the site, is known to have TCE contamination. The Mulberry Well is currently offline and is being pumped to waste to provide hydraulic control of the TCE contaminated groundwater in Camdenton. The Camden County PWSD # 2 wells are separate from the City of Camdenton public water system and are not known to be affected by TCE contamination at this time

Chromium, copper and lead are metallic elements that are not subject to degradation by natural causes. Although these elements do not degrade or disappear after being released into the environment they can change form based on the properties of the aquifer within which they are found. The toxicity of chromium varies based on whether the valence state is Cr^{+3} or Cr^{+6}, with the Cr^{+6} (hexavalent chromium) exhibiting greater carcinogenicity when ingested (ATSDR, 2012). Therefore, concentrations of hexavalent chromium are of interest when assessing the health based risks to drinking water consumers.

3.4 Study Questions

- Do private wells within ½ mile of the Camdenton Sludge Disposal Area contain site related contaminants of concern (TCE, chromium, barium, copper, etc.) associated with the Camdenton Sludge Disposal Area?

3.5 Inputs to Study Questions

The following lists the primary inputs required to address the principal study questions.

- Concentrations of Volatile Organic Contaminants (VOCs such as TCE and it's degradation products), arsenic, barium, cadmium, chromium, copper, lead, selenium and

silver in private drinking water wells within ½ mile of the Camdenton Sludge Disposal Area.

- Sources considered for health-based drinking water screening levels include; SCDM, EPA MCLs for Drinking Water, and EPA Regional Screening Levels (RSLs). The EPA MCLs and lowest health-based screening level (if different) for each contaminant of concern are provided in Table 4.

Table 4. Health-Based Screening Levels for Drinking Water (ug/L)		
Contaminant	**EPA MCL**	**Lowest Screening Level**
Arsenic	10	0.052
Trichloroethylene	5	2.6
1,2-Dichloroethylene	70	28
Barium	2,000	380
Cadmium	5	5
Chromium (total)	100	100
Copper	1,300	620
Selenium	50	50
Lead	15	15
Silver	NA	9.4

3.6 Study Boundary

The department identified 10 drinking water wells within ½ mile of the Camdenton Sludge Disposal Area that have granted the department permission to sample. Based on findings from this investigation, it may be necessary to identify additional wells further from the source of contamination.

3.7 Decision Rules

Well water results will be compared to the EPA MCL, or, when no MCL is available, to the lowest screening level in Table 4. If the result for any contaminant exceeds the MCL or screening level, otherwise, no further CERCLA assessment will be recommended for the well. If one or more wells within the identified ½ mile distance ring of the sludge disposal area are determined to have been the department will consider identifying and sampling at additional private wells further out from the source area.

Furthermore, if total chromium concentrations exceed the $1X10^4$ risk level for hexavalent chromium (3.5 ug/L) in a given sample follow up sampling will be conducted to quantify hexavalent chromium content.

3.8 Tolerable Limits on Decision Error

The hypothesis of this investigation is that VOCs and metals have been released into the groundwater surrounding the Camdenton Sludge Disposal Area Site. Falsely rejecting that hypothesis, considered a Type I decision error, would mean mistakenly concluding that there has been no release of contaminants to the groundwater, when in fact there has. Falsely accepting this hypothesis, considered the Type II decision error, would mean concluding that there has been a release of contaminants from the Camdenton Sludge Disposal Area site when in fact there has not been a release.

The Type I error could result in concluding that contaminants, such as TCE and harmful metals, have not been released into the environment when in fact they have. This could result in health consequences to individuals who depend on the Ozark Aquifer for their drinking water. A Type II error would potentially result in removal or remedial actions at the sludge disposal site which may not be necessary to protect the local portion of the Ozark Aquifer. The Type I error is

considered more severe since it could result in delaying actions needed at the site to protect public health.

Several measures will be taken to reduce the probability of making a Type I decision error, including collection of duplicate samples and trip blanks. Results will be compared to EPA's Maximum Contaminant Levels for drinking water which are established using conservative toxicity and exposure assumptions, further protecting against Type I errors. The use of a multiple lines of evidence approach will further reduce the likelihood of committing either type of decision error.

4.0 Field Activities

4.1 Sample Collection

Private well samples will be collected from at a point closest to the well head as available. The tap will be opened at a high flow for five minutes. Specific conductivity, pH, and temperature will be monitored during purging. The well will continue to run for an additional three minutes and field measurements will be collected again. If all the parameters are considered stable, (pH within 0.2 units, temperature and specific conductivity within +/- 10%) a sample will be collected. If water quality parameters are not within stable range then the tap will continue to operate for an additional three minutes and this will repeat until stabilization occurs. Groundwater samples collected for dissolved metals analysis will be filtered in the field prior to submission to the laboratory. The samples will be labeled, recorded on chain of custody forms and stored on ice until submission to the laboratory for analysis.

Locational data will be collected at each wellhead using a Trimble GeoExplorer handheld global positioning system (GPS) and a minimum logging time of 60 seconds. Locational data will be corrected using post-processing.

4.2 Sample Analysis

Samples submitted to the department's laboratory will be analyzed by EPA Method 200.8 for the following total and dissolved metals: arsenic, barium, cadmium, chromium, copper, selenium, lead and zinc. In addition to metals analysis, samples will be analyzed for volatile organic contaminants using 524.2. Table 5 provides the minimum sensitivity requirements for each contaminant of concern for this project.

Table 5.
Minimum Reporting Levels for Drinking Water Samples

Metal	Reporting Limit, µg/l
Arsenic	1.5
Trichloroethylene	0.5
1,2-Dichloroethylene	0.5
Barium	1.0
Cadmium	1.0
Chromium (total)	1.0
Copper	1.0
Selenium	10
Lead	1.0
Silver	1.0

4.3 Number of Samples, and Container and Preservation

Table 6 provides an estimate of the number of samples to be collected, sample container types and preservation requirements for the project. The exact number of samples may vary based on access obtained.

Table 6.
Sample Numbers, Containers and Preservation

Sample Type	Analysis	Approximate Number	Container/Preservation
Private Well Drinking Water (including field duplicates)	Total and Dissolved Metals (EPA Method 200.8)	10	125 ml Nalgene Bottle HNO_2 to pH <2 Store at 2^0C
Private Well Drinking Water (including field duplicates)	Volatile Organics Contaminant (EPA Method 524.2)	10	Two 40ml Amber glass vials with Teflon lined cap. HCL/ store at <6°C

4.4 Chain-of-Custody

All samples will be entered onto an ESP Chain of Custody (COC) form to be relinquished to a sample custodian at the department's Environmental laboratory for analysis. The COC form is included in Appendix C.

5.0 Quality Control (QC)

5.1 Field Decontamination

Clean disposable latex gloves will be worn by sampling personnel and clean or field decontaminated equipment will be utilized for each sample location to minimize the possibility of cross-contamination.

5.2 Quality Assurance/Quality Control (QA/QC) Samples

The following samples will be collected as part of the quality control/quality assurance procedures for the investigation (MDNR, 2012).

5.2.1 Duplicate Groundwater Sample

Duplicate groundwater samples will be collected at a frequency of 10% of samples collected to assess overall sampling and analysis precision in accordance with the SOP MDNR-ESP-210. Precision will be assessed from the relative percent difference between duplicate sample results and should be below 30%.

5.2.3 Trip Blank

A single trip blank will be used to estimate bias due to cross-contamination during sample storage and transport.

5.2.5 Laboratory QC

Laboratory precision and accuracy will be assessed as described in the QAPP for Pre-Remedial/Pre-Removal and Targeted Brownfields Site Assessments Revision 7, December 7, 2012 and ongoing (MDNR, 2012).

6.0 Investigation Derived Wastes (IDW) Plan

Disposable PPE and disposable sampling equipment will generally be handled as solid waste, containerized, and properly disposed.

7.0 Site Safety

A safety briefing will be held on-site prior to initiating field activities and field personnel will be required to read and sign the site-specific health and safety plan. The site health and safety plan is attached as Appendix A.

8.0 Reporting

ESP will prepare a Sampling Report including a copy of the field notes, chain of custodies and laboratory result sheets. SAU will prepare a Site Reassessment Investigation Report.

REFERENCES

ATSDR, 2012 — Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, Chromium ToxFAQs™ Information Sheet. Atlanta GA, 2012.

Bachle, 2017a — Peter Bachle, Geologist, Geological Survey Program, Missouri Geological Survey, Missouri Department of Natural Resources, Addendum Geohydrologic Summary of Camdenton TCE Sites. Rolla MO, September 8, 2017.

Bachle, 2017b — Peter Bachle, Geologist, Geological Survey Program, Missouri Geological Survey, Missouri Department of Natural Resources, Four-Mile Well Survey for the Camdenton Sludge Disposal Site. Rolla MO, September 13, 2017.

Elfrink, 1999 — Elfrink, Neil. Geologist, Geological Survey Program, Missouri Geological Survey, Missouri Department of Natural Resources. Memorandum to Valerie Wilder Subject: Hydrologeologic Report for the Camdenton Sludge Disposal Area, March 26, 1999.

MDNR, 1999 — Wilder, Valerie, Environmental Specialist, Hazardous Waste Program Superfund Section, Missouri Department of Natural Resources, Combined Preliminary Assessment/ Site Inspection, Camdenton Sludge Disposal Area Site Camden County, Missouri. March 30, 1999.

MDNR, 2012 Missouri Department of Natural Resources, QAPP for Pre-Remedial, Pre-Removal and Targeted Brownfields Assessments, December 7, 2012.

USDA, 1994 United States Department of Agriculture, Natural Resources Conservation Service. Soil Survey of Camden County, Missouri.2007.

SIGNATURES

Prepared by: ____________________________

Keith Brown
Environmental Specialist
Site Assessment Unit
Hazardous Waste Program

____

Sean Counihan
Environmental Specialist
Field Services Unit
Environmental Services Program

____

Approved by: Valerie Wilder
Section Chief
Superfund Section
Hazardous Waste Program

Date: ____________________________

APPENDIX A

Health & Safety Plan

MISSOURI DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL QUALITY
ENVIRONMENTAL SERVICES PROGRAM

SITE HEALTH AND SAFETY PLAN

1.0 INTRODUCTION

This plan has been prepared for implementation by DNR employees, using operating procedures for which they are specifically trained. Any use of the plan by other agencies, organizations, or private individuals is at their own risk.

2.0 KEY PERSONNEL

MDNR OSC: Sean Counihan ________ SAFETY OFFICER: Sean Counihan

OTHER MDNR PERSONNEL/TITLE:

Keith Brown, Environmental Specialist ________

____

____

3.0 SITE INFORMATION

Site name: Camdenton Sludge Disposal Area Site County/City: Camden County City of Camdenton ________

Sampling date: 10/2/2017________ Site Description: In 1989, sludge waste from Hulett Lagoon (which contained VOCs and metals with potential levels of concern) was land applied on the current property of the Camdenton Airport. Previous studies did not find any levels of concern, but due to citizen concern over TCE contamination to the groundwater the investigation is being reopened. ________

____

3.1 Overall Incident Risk/Hazard Analysis

Chemical: _______Serious________Moderate X Low _______Unknown

Physical: _______Serious________Moderate X Low _______Unknown

3.2 Contaminant(s) of Concern: ________

____

3.2.1 Physical State: X______Liquid_________Solid _______Sludge_________Gas/Vapor

Chemical Characteristics: (check all that apply)

X a. carcinogen	_______b. biological	_______c. corrosive	_______d. combustible
______e. explosive	_______f. flammable	X g. volatile	_______h. poison
______i. radioactive	_______j. reactive	_______k. other: ________	

3.2.2 Physical Hazards: (check all that apply)

a. ______overhead ________b. below grade ________c. confined space* ________d. noise
e. X____splash ________f. fire/burn ________g. puncture ________h. heat stress
i.______cut X______j. slip/trip/fall ________k. cold stress ________l. electrical
m.______mechanical/heavy equipment ________n. other:______________________________________

* The need for confined space entry by ESP personnel shall be evaluated on a site-by-site basis. A confined space entry permit must be signed by the appropriate Unit or Section Chief prior to ESP employees entering a confined space (29 CFR 1910.146). Confined space entry shall be screened in at least Level B prior to downgrade. **Adequate resources must be available and specific planning and tasks determined before confined space entry is initiated.**

3.3 Task-Specific Risk Analysis (attach additional sheets as necessary)

Task Description	Chemical Hazards	Physical Hazards	Level of Protection
Sampling	a,g	e,j	D
	a b c d e f g h i j k	a b c d e f g h i j k l m n	
	a b c d e f g h i j k	a b c d e f g h i j k l m n	
	a b c d e f g h i j k	a b c d e f g h i j k l m n	
	a b c d e f g h i j k	a b c d e f g h i j k l m n	

4.0 MEDICAL SURVEILLANCE AND PERSONNEL TRAINING REQUIREMENTS

All ESP field personnel participate in a medical monitoring program and are trained at least to the level of "Hazardous Substance Emergency Response-Technician" as required and specified in the department's written health and safety program located in Section 2 of the MDNR-Hazardous Substances Emergency Response Plan (HSERP). The written policy satisfies requirements set out in 29 CFR 1910.120. MDNR ESP's respiratory protection program meets the requirements of 29 CFR 1910.134.

ESP personnel will ascertain as much information as possible regarding health and safety issues associated with the site prior to initial entry. Information shall include chemical and physical hazards as listed above, types and amounts of materials involved, and citizens/areas threatened by the incident.

5.0 PERSONAL PROTECTIVE EQUIPMENT

ESP shall utilize the Protection Level categories defined in 29 CFR 1910.120, Appendix B, and known as Levels A, B, C, and D. Refer to Section 2 of the MDNR-HSERP for definitions of Protection Levels. ESP personnel shall inspect APRs and SCBAs at least monthly and maintain a record of such to ensure equipment is functional.

Levels of protection shall be reassessed and upgraded as conditions change and information is updated to comply with worker safety while performing site activities.

Action Levels for evacuation of work zone pending reassessment of conditions:

X Level D: O_2 < 19.5% or > 25%; explosive atmosphere > 10% LEL; organic vapors > background levels; othe

X Level C: O_2 < 19.5% or > 25%; explosive atmosphere > 20% LEL; organic vapors (in breathing zone) > 5 m.

X Level B: O_2 Explosive atmosphere > 20% LEL; unknown organic vapors (in breathing zone) > 500 m.u.; oth

X Level A: ESP personnel shall evaluate the need for entry on a site-specific basis and may utilize its emergency response contractor for Level A situations which may arise.

6.0 FREQUENCY AND TYPE OF AIR MONITORING/SAMPLING

Instrument	Contaminant of Concern	Sample Location (Area/Source)	Frequency	Odor Threshold/ Description

7.0 SITE CONTROL MEASURES

7.1 The "Buddy-System": ESP personnel performing any work activities within the exclusion zone shall employ the "buddy-system" at all times, as required and defined in Section 2 of the MDNR-HSERP. The "buddy-system" may not be required while an ESP staff member is observing or providing oversight of cleanup activities performed by a contractor or responsible party.

7.2 Safe work Practices: Refer to Section 2 of the MDNR-HSERP for written safety practices to be followed at all times by ESP personnel while on-site at an incident.

7.3 Site Communications: The use of two-way radios or establishment of hand signals for communications shall be determined prior to entering the work zone and followed by ESP personnel.

7.4 Radiation Safety: Due to the possibility of an unknown radiation hazard being present on a site, ESP personnel shall be required to wear radiation indicator badges (TLD badges) while on-site.

7.5 Work Zones: ESP personnel shall ensure work zones are established and be aware of their locations.

8.0 DECONTAMINATION PROCEDURE/SOLUTIONS:

Personnel: Gloves and clothing will be placed in a garbage bag and returned to Jefferson City for proper disposal.

Equipment: Returned to Jefferson City for proper decontamination.

Instruments: Returned to Jefferson City for proper decontamination or disposed of back in Jefferson City.

Decontamination fluids/materials may be to be containerized for proper disposal.

9.0 EMERGENCY INFORMATION:

In the event of an emergency, notify the MDNR Environmental Emergency Response Office at 573/634-2436. The Duty Officer will make the appropriate notifications.

10.0 ADDITIONAL EMERGENCY INFORMATION/NUMBERS:

Hospital: Lake Regional Hospital

Location/Specific directions from Site: 54 Hospital Drive, Osage Beach, MO See attached map for direction.

Name/Location	Telephone Number
Ambulance: Camden Ambulance District	573-346-3547
Police/Sheriff: City of Camdenton Police	573-346-3604
Fire: Mid-County Fire Protection District	573-346-2049
Poision Control:	
Cellular Telephones/Other:	
1) Central Accident Reporting Office- WORK RELATED INJURY	1-800-624-2354

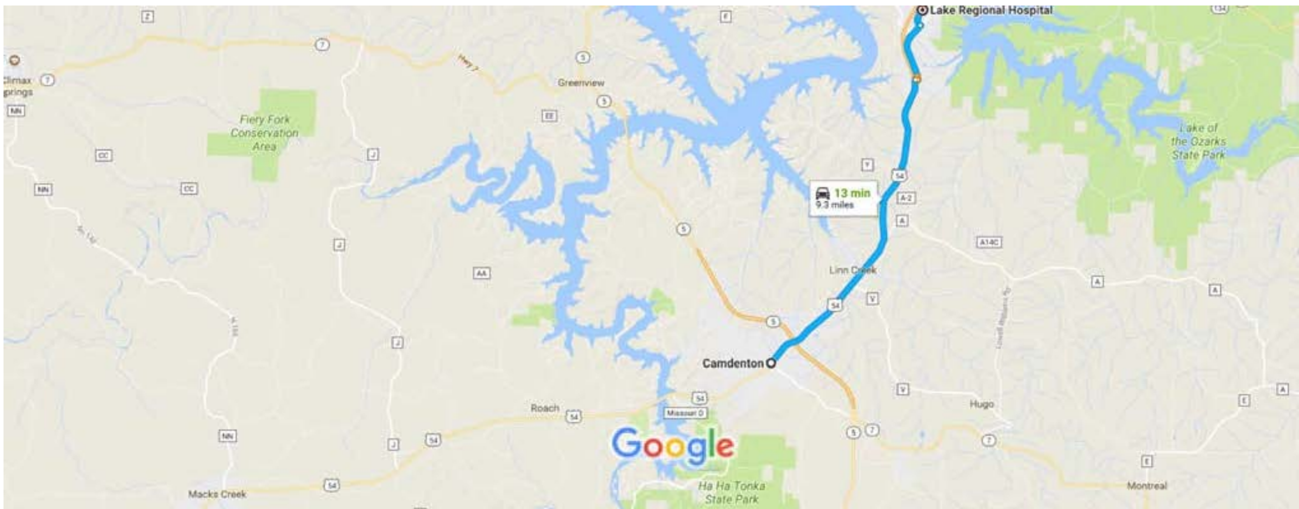
This number is to be called in the event of a NON LIFE THREATENING injury PROIR to seeking medical care.

11.0 SIGNATURES

ESP personnel shall certify they have read the plan and addressed any questions regarding worker health and safety by signing and dating below followed by printing their name and title.

Signature	Printed Name/Title	Date	TLD Badge

Google Maps Camdenton, MO to Lake Regional Hospital Drive 9.3 miles, 13 min



Map data ©2017 Google United States 2 mi

Camdenton

Missouri 65020

1. Head northeast on US-54 E toward Camden Ct — 7.5 mi
2. Turn right onto Old U.S. 54 (signs for Business 54/Osage County Pkwy) — 302 ft
3. Turn left onto Old U.S. 54/Osage Beach Pkwy — 1.3 mi
4. Turn left onto Ozark Care Dr — 0.3 mi
5. Turn left at the 1st cross street onto Hospital Dr — 0.1 mi

6. Turn right to stay on Hospital Dr

Destination will be on the right

312 ft

Lake Regional Hospital

54 Hospital Dr, Osage Beach, MO 65065

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the

APPENDIX B

Figures

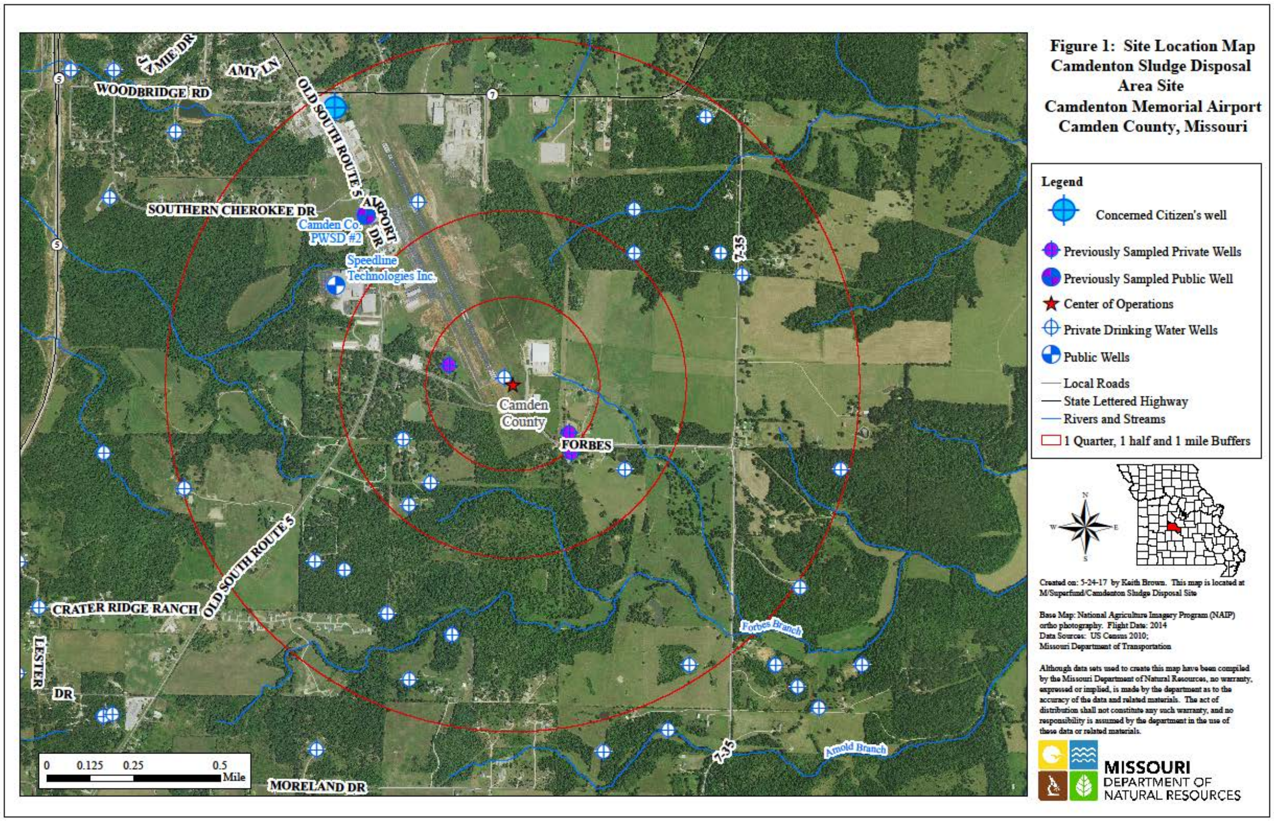


Figure 1. Site Location Map of the Camdenton Sludge Disposal Area

APPENDIX C

Field Sheets

Chain of Custody Forms

Missouri Department of Natural Resources

CAMDENTON SLUDGE DISPOSAL SITE
FIELD SHEET

LOCATION ID __________

Owner Contact Information:

Name(s):________________________________**Signature:** ________________________________
(I give MDNR permission to sample my well)

Physical Address of Property Sampled
(Street, City, State, Zip):____

Mailing Address (if diff):____
Phone 1: ______________ **Phone 2:** ____________________

Residence on Property? Yes □ No □ **Owner Occupied? Yes □ No □**

Occupant Contact Info (fill-out only if not owner-occupied):

Name(s):____

Address (Street, City, State, Zip):____
Phone 1: ______________ **Phone 2:** ____________________

Number of Residents: __________**Number of Children & Ages:** __________

Northing:______________ **Easting:**____________________ **(UTM)**

Physical Description of House/Property:

Well Depth (ft)__________ **Well Age (yrs)**__________
Well Use (Drinking, Livestock, etc.): _______________
Water Treatment System No_____ **Yes**_____ **If yes what type:**______________________________
Does well serve >1 residence? ____ **If so, how many and list:** ______________________________
____

Is the residence connected to municipal water supply Yes____ **No**____
If yes what city and list uses of private well____

Comments:

Permission to Sample Granted Verbally By: __________________________ **On (date):** __________

Lab Sample Number: ______________
____

Purge Time (min)	pH	Temp, ^0C	Spec. Cond., µS/cm
5			
6			

DEPARTMENT OF NATURAL RESOURCES
Division of Environmental Quality

TELEPHONE OR CONFERENCE RECORD

FILE: Camdenton Sludge Disposal Area — DATE: 6-20-17

TELEPHONE:	CONFERENCE:
Incoming ()	Field ()
Outgoing (X)	Office (X)

SUBJECT: Citizen concerns regarding TCE contamination in Camdenton Area

PERSONS INVOLVED:	REPRESENTING:
Keith Brown	MoDNR, HWP, Superfund
Valerie Wilder	MoDNR, HWP, Superfund
Carolyn Burns	Self/concerned citizens

SUMMARY OF CONVERSATION:
Mrs. Burns was contacted by phone to discuss her concerns about additional sites in the Camdenton area that may have TCE contamination. She had previously left a message with EPA Region 7 regarding concerns about TCE contamination and potential buried drum disposal in Camdenton.

Mrs. Burns reported that she had worked for Dawson/Sundstrand for 38 years and was a longtime resident in the Camdenton community. While working at Dawson/Sundstrand she had been exposed to TCE in her eye. Mrs. Burns stated that she has experienced health issues and is concerned that others in the community may be exposed to TCE and have adverse health impacts. She had several health related questions about her TCE exposure and possible links to cancer. Mrs. Burns stated that many individuals in the community have been diagnosed with cancer. We stated that Missouri Department of Health and Senior Services (MDHSS) would be best equipped to answer health related questions regarding TCE exposure.

Mrs. Burns stated that Mr. Dawson stored TCE mixed with waste oil in 55 gallon drums at the Sunset Dr. facility and that she had heard that he had buried multiple drums of TCE on site sometime around 1973. Valerie Wilder asked if she had personally seen Mr. Dawson burying the drums and she said “No, but several people have told me that it happened.”

Mrs. Burns then stated that after a fire in 1972 at the original Dawson Metal Products building on Sunset Drive, operations were temporarily moved to the “old Cox building” on Highway 54,

which is now the site of Laker Fishing Tackle. Mrs. Burns reported that she had heard that TCE was also “dumped out a back door” during operations at the Old Cox building on Highway 54, which was reported to have been only about one year. When asked by Valerie Wilder whether she witnessed dumping of TCE at the Old Cox building Mrs. Burns said “No, but a lot of people saw it.” Mrs. Burns confided that many of the people who saw the dumping occur may have passed away.

Mrs. Burns then discussed the removal of sewage sludge from Hulett Lagoon and deposition at the Camdenton Airport. She stated that her husband had worked for Mr. Tidgren who had put Hulett Lagoon sludge on his field. When pressed for an exact location of this field, Mrs. Burns relayed that the property was near the intersection of Panoramic Drive and Ha Ha Tonka Road, near the sewage treatment plant “by a big old barn”. She stated that this location was used as a temporary storage area for the sludge before disposal at the Airport, but that some sludge may have been permanently deposited there as well. Mrs. Burns also stated that Hulett Lagoon sludge also may have been deposited on Larry Coleman’s property. Mrs. Burns stated that Larry Coleman had worked for the city at the time, but has since retired. When asked what was done with the Hulettt Lagoon sludge at Mr. Coleman’s property Mrs. Burns said that it was applied to fields.

<u>ACTION TAKEN</u>:
DNR referred Ms. Burns health related questions to Dennis Wambuguh and Michelle Hartman at MDHSS.
The Department will follow up on the remaining information regarding TCE in the environment.

Superfund Site Assessment Unit Chief	Date of Signature
Environmental Specialist	Date of Signature

DEPARTMENT OF NATURAL RESOURCES
Division of Environmental Quality

SITE VISIT RECORD

FILE: Camdenton Sludge Disposal Area DATE: July 26, 2017

PERSONS INVOLVED:	REPRESENTING:
Amanda Branson	MoDNR, HWP, Superfund
Terry Ball	MoDNR, Private Investigator
Keith Brown	MoDNR, HWP, Superfund
Larry Coleman	Former City of Camdenton Employee

SUMMARY OF CONVERSATION:

MoDNR staff arrived at Mr. Coleman's property at approximately 1230 PM and found him working on a vehicle in the yard. Terry Ball asked if Mr. Coleman had a minute to talk and he responded "Yes". Mr. Coleman confirmed that he had worked for the city (of Camdenton) for about 13 years, ending in 2003.

Terry Ball asked, "What did you do for the City?" Mr. Coleman responded that he maintained the (sewage) lift stations and hauled sludge. When asked where the sludge was hauled to he said "Here [meaning Coleman property]; Carl Tidgren's property, the airport and Larry Mueller's."

Terry Ball then asked "Where did the sludge come from?" and Mr. Coleman said "From the treatment plant. I never hauled any sludge from Hulett Lagoon." Terry Ball asked if it was done 'by the book' and Mr. Coleman replied "Pretty much."

Mr. Coleman said he owned two properties, an 80 acre parcel with his house and another 120 acre parcel elsewhere for a total of 200 acres. Mr. Coleman said that he had land applied sewage sludge to his fields to improve fertility and that he cuts hay and pastures livestock on his land.

Terry asked if the city had tested for metals in the sludge and Mr. Coleman replied "Just copper, no others". When asked if the sludge ever tested over specifications Mr. Coleman responded "Yes, the lagoon below Dawson's/ Sundstrand did." Terry asked if he had worked there (Dawson's) and Mr. Coleman said "no, but I know others who did: Jerry Rogers, Dale Bland, Carol- Sue Hindball (Carolyn Burns). Dale Bland operated a (TCE) pre-treatment plant inside the factory. This is deadly serious."

When asked what made him believe that his well was contaminated Coleman responded "DNR made the City clean out Hulett Lagoon and they put it right up there at the airport. I saw them do

it. There was 2,681 cubic feet of toxic waste from there. That factory was dumping (contaminants) into the lagoon from 1967 -1987."

Mr. Coleman mentioned that Ronnie Testerman was the MoDNR contact for the sludge disposal and that "They (the City of Camdenton) weren't supposed to touch it for 100 years…..then the city expanded the runway anyways. TCE, cadmium, cyanide- when you bury it, it goes into the groundwater."

Mr. Coleman continued, saying "…I was the inspector at the (Hulett) lagoon. It was very rainy that year. They had a certain amount of time (to complete the project contract) and the manure spreader broke. They may have spread 20% (of the sludge) but the rest was buried. You guys (MoDNR?) were as guilty as the City of Camdenton."

After further questioning Mr. Coleman described the location where the majority of the sludge was buried as a draw that ran across a portion of the airport field. Mr. Coleman said "158 feet back (from the road) and it's there."

Keith Brown asked if it was green colored and Mr. Coleman replied "Yes, it was green colored. I had a sample of it –it was green, but I got rid of it."

Terry Ball asked Mr. Coleman if they (the City) covered all of it (sludge disposal area) with the runway and he responded "Pretty much."

Mr. Coleman mentioned that he had gotten "written up" by the city for complaining about the sludge disposal and that he got additional write-ups from the city for complaining about sewage and Modine effluent running into the Lake of the Ozarks when Lift 7 was broken down. He said that they told him to put a chlorine tab in when the (Hulett) lagoon overflowed into the lake. He said "That factory (Dawson/Sundstrand/Modine) released 30,000 gallons a day six days a week with three shifts working." Mr. Coleman mentioned that there was an electroplating unit at the Modine factory and that he had concerns about cadmium contamination.

Mr. Coleman described an incident when he saw discolored water flowing in a normally dry creek bed during dry weather and he followed the creek up stream and ended up at the Modine facility. Describing it further he said, "There was a white powder on all of the rocks in the creek."

Mr. Coleman went on to describe the removal of sludge from Hulett lagoon saying "… they only took 5/8 or maybe ¾ of the lagoon soil, the rest they left there and covered over with soil."

Mr. Coleman mentioned the fire at Dawson's metals in 1972 and said that they (Dawson's) moved operations to the Cox building.

Mr. Coleman described the contamination in Mulberry well and how he believed that the city continued to pump from Mulberry well after they knew it contained TCE.

Mr. Coleman was asked again whether sludge from Hulett Lagoon had been applied to areas other than at the airport and he said “No, I hadn’t heard that.”

Mr. Coleman relayed that he had heard rumors that Modine had buried drums by Niangua branch, but that it was just hearsay as far as he knew.

When asked whether he would give MoDNR permission to sample his well again Mr. Coleman said “Yes, you can sample it right now!” He said that his neighbor, Scott Martin would also be willing to have his well sampled. Mr. Coleman mentioned that there was a Camden county well near the airport (Camden County Public Water Supply District # 2 Well) that is no longer pumped.

Mr. Coleman then described an incident when Hulett lagoon was covered in orange foam that he believed was caused by an influx of Modine industrial effluent. He said that the lagoon was shut down for six weeks after that incident and that they had to reintroduce microbes when they started it up again because the industrial effluent had killed everything in the lagoon.

Mr. Coleman said that they (Modine) did that to Hulett Lagoon twice and then the city requested that they receive notice before Modine release large quantities of effluent like that. He said that he thinks that Modine had a large tank that they would release occasionally. Mr. Coleman said that when they got notice from Modine that they were going to release a large quantity of industrial effluent that they (the city) would “Put it on CP White lagoon.” When asked where CP White Lagoon was located Mr. Coleman said “It is down off Ha Ha Tonks Road, behind the city treatment plant.” Mr. Coleman said that we should check with Bob Marshall (another former City of Camdenton employee) and that he may talk to us (MoDNR) about what had happened. Mr. Coleman said that he believed that the city had gotten rid of their files on Hulett Lagoon. Mr. Coleman gave a current phone number to reach him and said that he is usually home after 11 am. MoDNR staff thanked him for his time and said that they will most likely be back to sample his (and his neighbor’s) well.

<u>ACTION TAKEN</u>:
MoDNR and City of Camdenton records will be examined to verify claims put forward by Mr. Coleman. A sampling plan will be drafted proposing sampling of private wells in the area surrounding Camdenton Municipal Airport for volatile organic contaminants and metals.

Environmental Specialist　　　　　　　　Date of Signature

Former Hulett Lagoon Site
Combined PA/SI
Reference 31

Attached herewith you will find a letter dated November 01 1989 written to Attorney David Welch from Charlie Ray with Missouri Engineering Corporation, along with the Information for Bidders, Proposal Form, additional information for the contractor, and Change Order Nos 3 and 4 concerning the sludge removal at the Hulett Lagoon.

I personally inspected the sludge site at the airport with Kent and Charlie on Wednesday, October 25, 1989. Upon our inspection, it was found that there is soil that was removed from the lagoon, but there are traces of sludge mixed in with the soil.

I will be the first to admit that I am by far no expert on sludge, but is my feeling that if sludge was present at the lagoon, that it should be removed. This being not only to satisfy my concerns, but maybe more importantly, to satisfy DNR. I believe you will agree that we do not want any trouble with DNR over this lagoon sludge removal.

I realize the Mayor or Council was not advised of the additional loads being removed from the lagoon at the time, but let's just suppose we had been told beforehand that additional loads needed to be removed. . .then, would we have said no? Would we have been expert enough to know that no more sludge needed to be removed from the lagoon? Please just take a minute and think about it.

As Charlie states in his letter, weather conditions were not ideal at the time sludge was being pumped from the lagoon, and there were delays, plus each time the rains came, this caused the sludge to spread back over the area of the lagoon, which I feel would need to be removed. Apparently, the contractor felt it necessary to remove the additional soil, as it was contaminated with sludge Although, after the sludge was removed and taken to the stockpile sight and dried out, the majority removed was soil, BUT there was a percentange of sludge in the soil that was tested.

Charles also states that more tests can be performed on the soil at the stockpile sit, but you will note that the eight tests that were run cost $1000.00. Do we want to keep testing the soil and spending thousands of dollars for this?

You will note in the information attached to Charlie's letter, on page GC-20 under No. 30 ARBITRATION, that disputes will be settled by arbitration. Although, some of you may not be too familiar with arbitration, I deal with it everyday in my work, and it has been my experience that this is not the easiest way to prove a point. You may think your case is airtight, but the arbitration committee can easily blow your case right out of the water. I personally believe that if the arbitration committee saw that there was a percentage of sludge in the excess soil removed from the lagon, that they would rule in favor of the contractor Be advised this is my personal opinion, but also, I have dealt with arbitration committees for several years. Our attorney may disagree with me totally, but I do feel very strongly on this point.

I feel we can sit in the council chambers and argue and hash this matter out for several hours, and never settle the dispute. As you know, each of us are separate individuals with our own way of thinking. I am not trying to persuade any one of you in any way, but please take a little time and think carefully about this matter and just maybe, you may reconsider allowing this matter to be resolved by paying the contractor on these change orders.

I do have information from a very reliable and trustworthy individual that McCormick has alread been told that an additional $3000 00+ that he has spent on this sludge removal project will not be taken into consideration for payment, and they have apparently accepted this fact

This matter can be discussed to some extent Tuesday night, but let's not drag it out for any length of time Please be advised that I do intend to make a motion for this additional money to be paid to McCormick and it will be up to the rest of the council to either agree or disagree Remember, in the meantime, the sludge is just sitting idle at the airport waiting to be spread

Thank you for taking the time to read this and reconsidering all the facts involved in this matter

Again, I respect each and everyone of you in the decisions we make as a council, and I do feel that we are a strong and aggressive council who face may tough decisions each time we sit in the council chambers

Sincerely,

Kay Cyrus

Missouri Engineering Corporation
ENGINEERING CONSULTANTS
P O BOX 13
ROLLA, MISSOURI 65401 • PHONE 314-364-4003

November 1, 1989

Dave Welch
Attorney at Law
190 Court Circle
Camdenton, MO 65020

Dear Dave:

Since our meeting Tuesday morning, I have tried to summarize the overall situation of payment on the Hulett Lagoon Sludge Removal and Stockpiling project. I have taken a set of the contract documents and marked what I felt was pertinent information regarding this matter. Mr. McCormick feels that he is due additional funds for sludge removal. I am in agreement with him that he has removed additional material but disagree that it was actually sludge.

The specifications were very clear that the quantities shown were only estimates and that final payment would be made on the quantities actually removed and measured. On GC-8, 13.1, it states that final measurements shall not be considered changes in the work. It also states in the specifications that differing site conditions or weather conditions can govern the work to be performed and paid for. This project is very unique and the conditions encountered during the removal period were not ideal. As you are aware, the Department of Natural Resources had complete control on the approval of this material being removed, but it was at a total cost paid by the City of Camdenton.

The scope of the project included complete removal of the sludge from the lagoon site and stockpiling of this material at the south end of the airport property. I have had conversations with Mr. McCormick over concerns of the project and will try to highlight those in the following statements.

1. I have been told that even though the contractor was prepared to begin removal of the sludge during the last weeks of June, that he was told by the city to not start until after the July 4th holiday period. We lost two weeks of very favorable working days.

2. The removal process began on July 11, 1989. They had hauled approximately 650 cubic yards through July 12 at 1:30 p.m. At that time my inspector told me that they were way less than one-half done with the area. I asked how much dirt was being removed with the sludge. Was it a clean separation? The answer was that the excavation was being made to a level that showed clay material. I aksed my inspector to have Mr. McCormick to contact me.

3. Mr. McCormick called me to discuss the problems. He assured me that there was very little dirt being removed and absolutely no more than was necessary. I told him at that time, that if there was going to be more sludge, I had to take the increase to the council. His statement was that he felt that the total yardage would not exceed the 1500 cubic yards in the proposal by very much, maybe a hundred yards.

4. The sludge was left to dry after July 12. Rainfall filled the bottom of the lagoon during the following weeks and created additional pumping. The contractor attempted removal again on August 18 and 19. Rain again stopped the project on August 19.

5. After pumping on the lagoon again and drying the sludge, the contractor again started hauling on September 7 and 8. When work had stopped on August 19, I was advised by my inspector that they were nearly done and if it had not rained, they would have probably finished that day. They were at approximately 1485 cubic yards. After the rains and the contractor continued, he hauled approximately another 910 cubic yards.

In my opinion and as shown at the lagoon site, much of the soils were contaminated with copper each time the lagoon was refilled with rainwater. The reason this showed was because the copper settled out and oxidized causing the soils to appear as the same color of the sludge. Each time the contractor reworked the areas, he was forced to remove additional materials that must have appeared to be sludge when it was wet. After it dried at the stockpile site, it was obvious to me that most of it was soils. The test results that we had performed reflect that this is actually the case.

In eight samples taken from the stockpiled materials, an analysis was made to determine the sludge quantity. These are as follows:

1. 3.08% sludge
2. 0.37% sludge
3. 1.05% sludge
4. 1.53% sludge
5. 8.10% sludge
6. 33.35% sludge
7. 1.68% sludge
8. 2.03% sludge

Also the metals test show a considerable drop from the sludge samples analyzed before the project began. Concentrations of copper dropped from a high of 50,000 parts per million to a high of 5500 parts per million.

It is impossible to test every particle of the stockpiled materials to determine if this is totally representative, but I believe that is is a valid comparison. There are approximately 50 loads that would have to be tested to get an actual sludge analysis. These eight tests cost $1000.

I know that the council feels as if they were left out of this decision, but I do not think that they could have ever reached any other answer other than to continue to remove all necessary materials. This has always been the goal in order to satisfy DNR requirements.

It is my opinion, that the contractor did the work required in order to achieve the completion of the total sludge removal and should be compensated for the additional material removal in the amount of $7,826.50. In addition to this, if we continue with the project and spread the material at the airport, there would be an additional cost of $1,800 to spread the additional materials.

Hopefully this information will be of benefit to you. I would certainly like to see this issue resolved and the project completed.

Sincerely,

MISSOURI ENGINEERING CORP.

Charles Ray

Charles Ray
CR/vm

FILE: Camdenton Sludge Disposal Area PA/SI Site
CamdenCounty

MEMORANDUM

DATE: March 30, 1999

TO: Valerie Wilder, Environmental Specialist
Superfund Section, HWP, DEQ

FROM: Neil Elfrink, Geologist
Environmental Geology Section, GSP, DGLS

SUBJECT: Hydrogeologic Report for the Camdenton Sludge Disposal Area Site

LOCATION: NW 1/4, SE 1/4, SE 1/4, Section 4, T. 37 N., R. 16 W., Camden County, Missouri; 37º 58' 10" North Latitude and 92º 41' 20" West Longitude

The hydrogeologic report for the Camdenton Sludge Disposal Area site is enclosed. Please contact me at (573) 368-2162 if you have any questions regarding this report, or if additional information is required.

NE/lh

Attachments

HYDROGEOLOGIC REPORT FOR THE CAMDENTON SLUDGE DISPOSAL AREA CAMDENTON, CAMDEN COUNTY, MISSOURI

GENERAL CONSIDERATIONS

Site Location

The Camdenton Sludge Disposal Area is located on the Decaturville 7.5-minute quadrangle map (Figure 1), in the Northwest Quarter (NW 1/4) of the Southeast Quarter (SE 1/4) of the Southeast Quarter (SE 1/4) of Section 4, Township 37 North, Range 16 West. Coordinates for the center of the disposal area are approximately 37º 58' 10" north latitude and 92º 41' 20" west longitude. Elevation at the site is approximately 1,060 feet MSL. The Camdenton Sludge Disposal Area is located at the Camdenton Memorial Airport, south of the runway and north of County Road 5-120. The site is approximately 4.6 miles southeast the Former Hulett Lagoon Site. Contaminated soils from the Former Hulett Lagoon in Camdenton were transported to and disposed of at the Camdenton Sludge Disposal Area in 1988.

Physiographic Province

The site is situated on an upland in the Salem Plateau region of the Ozark Plateau physiographic province (Missouri Water Atlas, 1986). The topography of the Salem Plateau is characterized by a rolling upland surface with rugged hills dissected by entrenched, narrow stream valleys (Gann, 1976). Karst features, such as springs, sinkholes, and losing streams, are characteristic of the Salem Plateau.

GROUNDWATER PATHWAY

Stratigraphic Units

A stratigraphic column (Table 1) has been tabulated based upon the stratigraphy of nearby wells (Well Log File, 1999). The Camdenton Sludge Disposal Area has been included on a geologic map produced by Mark Middendorf (1984).

The youngest bedrock formation beneath the site is the Ordovician-age Roubidoux Formation, assigned to the Canadian Series. The Roubidoux Formation consists of dolomite, sandy dolomite, and sandstone (Thompson, 1991). In the Camdenton area, soluble portions of the Roubidoux have generally been removed by dissolution. Nearby well logs indicate that the Roubidoux Formation may consist of clayey residuum and sandstone, with only small lenses of carbonate rock remaining. In the headwaters of Racetrack Hollow, approximately ½ mile west of the site, erosion has completely removed the Roubidoux Formation and the underlying Gasconade Dolomite is exposed at the surface. Approximately 1½ miles northeast of the site, Jefferson City Dolomite exposures overlie the Roubidoux Formation (Middendorf, 1984).

Underlying the Roubidoux Formation, the Gasconade Dolomite consists of cherty

dolomite and is estimated to be approximately 280 feet thick in the vicinity of the site (Well Logs, 1999). A basal unit of the Gasconade Dolomite, known as the Gunter Sandstone Member, commonly separates the Ordovician- and Cambrian-age strata. The Gunter Sandstone is approximately 25 feet thick in the Camdenton Airport area.

Cambrian rocks in the Camdenton area were deposited in a complex depositional environment. The Camdenton Sludge Disposal Area is located near the western margin of a Cambrian-age intrashelf sedimentary basin known as the Central Missouri Basin (Palmer and Hayes, 1997). During Cambrian time, the Camdenton area was part of an emerging tectonic feature known as the Lebanon Arch. The north-south trending Lebanon Arch consists of carbonate platform rocks, that in some areas, thin over Precambrian highlands (Gregg et. al., 1989). The boundary between the Central Missouri Basin and the Lebanon Arch is transitional and poorly defined (Map E, Palmer and Hayes, 1997). Dramatically different lithologies and abrupt facies changes are depicted in area well logs (Figure 2). In general, more shaly, basinal rocks to the east pinch-out against the Lebanon Arch.

Because of the tectonic setting, Cambrian beds in the Camdenton area are difficult to categorize, and “layer-cake” stratigraphy should not be assumed. The following descriptions are simplified. The upper-most Cambrian unit in the area is the Eminence Dolomite, which consists of approximately 240 – 635 feet of dolomite with minor amounts of chert. The Eminence Dolomite is underlain by about 25 - 230 feet of Potosi Dolomite, which consists of dolomite, chert, and drusy quartz. Beneath the Potosi Dolomite, in descending order, are the Derby-Doerun Dolomite, the shaly Davis Formation, the Bonneterre Formation, and the Lamotte Sandstone. The entire Cambrian section is estimated to be over 1,150 feet thick.

Cross-sections constructed using information from specific well logs (Well Log Files, 1999) are presented in Figures 2 and 3. The cross-section locations are shown on Figures 1.

Aquifers

The Ozark Aquifer, which includes all bedrock units above the Cambrian-age Derby-Doerun Dolomite, is the shallowest aquifer beneath site. The Ozark Aquifer is considered exposed at the surface at the Camdenton Sludge Disposal Area. The total thickness of the aquifer is approximately 950 feet. Each of the units which comprise the Ozark Aquifer have individual characteristics that control their water-bearing capabilities; however, in general, the Ozark Aquifer produces good-quality water, with production rates generally proportional to well depth.

According to Harvey et. al. (1983, p. 38), there can be perhaps as many as three separate potentiometric surfaces within in the Ozark Aquifer in upland areas such as the Camdenton Sludge Disposal Area. Water levels in upland wells completed in the Roubidoux Formation range from 18 to 205 feet below the surface. Howver it is possible that the Roubidoux Formation present beneath this particular site is too thin to

contain groundwater. According to Harvey et. al. (1983), water levels in upland wells completed in the Gasconade Dolomite range from 14 to 300 feet below the surface, with an average depth to water of 150 feet. Water levels in upland wells completed in the Eminence Dolomite and deeper formations range from 15 to 407 feet below the surface, with an average depth to water of 200 feet. The multiple water-level phenomenon common in upland areas suggests significant local recharge to the deeper portions of the Ozark Aquifer.

Differences in head between shallow and deep portions of the Ozark Aquifer are typical in upland areas such as the Camdenton Sludge Disposal Area. The site is expected to be a groundwater recharge zone. Extensive pumping of deeper groundwater can increase the downward vertical gradient. The Camdenton Airport Well is reportedly used only once per week with the bulk of water being supplied by Well #2 located approximately 3 miles south of the Camdenton Sludge Disposal Area. Nearby domestic wells can also contribute to an increase in downward gradient. Pumping rates at the Camdenton Airport Well may be high enough to engulf the site within a cone of depression. The radius of influence of nearby production wells should be determined.

Because detailed hydrogeologic studies have not been conducted at the site, groundwater flow directions within the bedrock can only be approximated. According to the potentiometric map of the Roubidoux-Gasconade sequence in "Hydrology of Carbonate Terrane – Niangua, Osage Fork, and Grandglaize Basins, Missouri" (Harvey, et. al., 1983, Figure 13), shallow groundwater beneath the site could flow eastward toward Dry Auglaize Creek. However, according to Figure 15 "Generalized direction of groundwater flow in the Niangua, Osage Fork, and Grandglaize basins" published in the Water Resources Guide No. 35 (Harvey, et. al., 1983), groundwater beneath the site could flow northwestward toward the Niangua Arm of the Lake of the Ozarks. Furthermore, dye traces have shown that surface water lost in Dry Auglaize Creek can cross the surface water divide and discharge into the Niangua River, northwest of the site. It is possible that both groundwater flow directions are correct. Shallow groundwater may flow toward Dry Auglaize Creek, while deeper groundwater may be diverted into the Niangua Basin.

Monitoring well nests are needed to accurately determine the magnitude of the downward vertical gradient. The upper Gasconade Dolomite *may* inhibit the downward migration of contamination. However, fracturing and karst development may have resulted in a local increase in permeability within the otherwise relatively tight upper Gasconade Dolomite.

The Gunter Sandstone is generally highly porous and permeable and is an important source of domestic groundwater supplies in the area. Because the Gunter Sandstone generally yields adequate domestic water supplies, few private wells in the area penetrate the underlying Cambrian Formations. However, municipal wells in the Lake of the Ozarks area are generally cased through the Gunter Sandstone, in order to avoid possible bacterial contamination.

The Eminence and Potosi Dolomites are a major source of municipal drinking water throughout the Ozark area, including the City of Camdenton. The Eminence Dolomite is differentiated from the underlying Potosi Dolomite by the lack of druse. A druse is a rock cavity encrusted with finely crystalline quartz. The druse-rich Potosi Dolomite is the most permeable geologic unit within the Ozark Aquifer and generally has an extensive network of karstic channels.

The shallowest reliable aquitard beneath the site is the St. Francois Confining Unit, approximately 1,150 feet below the surface. The St. Francois Confining Unit separates the Ozark Aquifer from the deeper St. Francois Aquifer. The St. Francois Aquifer includes the Cambrian-age Bonneterre Formation and Lamotte Sandstone. The St. Francois Aquifer is not used as a water source in Camden County. Water losses in the Lamotte Sandstone are common in some parts of the Ozark Region, although the phenomenon is poorly understood. Outside the St. Francois Mountain area, few water wells penetrate the Lamotte Sandstone, since yields may actually be reduced. Groundwater flow directions in the deeper St. Francois Aquifer are generally unknown and may be complicated.

Baseline water-level and pumping rate data need to be collected before informed decisions about groundwater movement in the Camdenton subsurface can be made. Static water levels should be measured at least monthly at any inactive wells. Detailed records of active wells should include volume of water pumped, length of pumping cycles, and drawdown measurements.

Aquifer Discontinuities

There are no aquifer discontinuities within a 4-mile radius of the site. Folds and faults in the area cannot be considered aquifer discontinuities for HRS scoring because their effects on groundwater movement are so poorly understood. Older faults have more highly-developed solution channels and may, therefore, act as groundwater conduits (Harvey et. al., 1983). Younger faults can actually act as aquitards, inhibiting groundwater flow

Wellhead Protection Area

The Former Hulett Lagoon site is located in a Wellhead Protection Area according to section 1428 of the Safe Drinking Water Act. In Missouri, Wellhead Protection Areas are designated by the Missouri Wellhead Protection Program. The Former Hulett Lagoon Area site is located within a 1-mile radius of a wellhead in a carbonate aquifer system (Public Drinking Water Program, 1994, page 15). The wellhead of concern is the Camdenton Airport Well.

Revisions to the 1994 Missouri Wellhead Protection Program document are currently under review by EPA. However, the Former Hulett Lagoon site should remain in a designated Wellhead Protection Area under any new management program that may be approved.

The Camdenton Sludge Disposal Area is located in Area 1, as designated by the DGLS Wellhead Protection Section. Since September 1987, Area 1 bedrock wells have been required to have 80 feet of casing and penetrate at least 30 feet of bedrock (Missouri Well Construction Rules, 1996).

Karst Features

The Camdenton Sludge Disposal Area is considered karst (Missouri Water Atlas, 1986). Significant karst features are present within a 4-mile radius of the site. Dissolution has caused the carbonate aquifers to be extremely heterogeneous (Harvey, et. al., 1983).

Geologic Structures

Geologic structures can influence groundwater movement (Harvey, et. al., 1983). The effects of the structural deformation on groundwater are poorly understood, but the faulting and folding has probably increased hydraulic conductivities in some areas. The northwest-trending structures in the Camdenton area tend to be older than northeast-trending structures. Northwest-trending structures may act as groundwater conduits.

Faults and folds have been mapped within the 4-mile groundwater target radius (Middendorf, 1984). Well log data suggest unmapped faults may also affect the area. A circular area of complex brecciation, known as the Decaturville Structure, lies just southwest of the 4-mile target radius (Wedge, in preparation). The Decaturville Structure is part of the Decaturville-Crooked Creek axis, a series of highly-faulted areas stretching eastward into Kentucky. The Mine Hollow Fault is shown on Figure 1 and located approximately 2/3 mile southeast of the Camdenton Sludge Disposal Area. The fault appears to radiate from the Decaturville Structure. The Mine Hollow Fault has a northeast trend and is downthrown approximately 60 feet to the northwest.

The axis of a northwest-trending syncline, called the Racetrack Hollow Syncline (Figure 1), has been mapped less than 2 miles west of the Camdenton Sludge Disposal Area (Middendorf, 1984). The Red Arrow Fault is located less than 3 miles southwest of the site (Wedge, in preparation). The Red Arrow Fault strikes northwest and, in general, the southwest side is downthrown approximately 100 feet. However, geology along the fault zone is complicated. LOGMAIN Well # 28602 (Figure 2) is located along the western portion of the fault zone and indicates significant upward movement. Ha Ha Tonka Spring is located along the trace of the Red Arrow Fault.

The poorly defined Proctor anticline runs across Camden County (McCracken, 1971). The Proctor Anticline changes to a fault in southern Camden County (Wedge, in prep.). The Proctor Fault (Figure 1) has been mapped less than 4 miles northeast of the Camdenton Sludge Disposal Area (Middendorf, 1984). The structure is probably related to a rejuvenated Precambrian fault.

Travel Time Factor

Rock layers that underlie the site are karst. The resulting Travel Time Factor Value is 35 (Federal Register, 1990).

GROUNDWATER TARGETS

Target Distance Limit

Groundwater use within the 4-mile groundwater target distance limit is extensive. Most residences near the Camdenton Sludge Disposal Area utilize private wells.

Wells

Over 92 drinking-water well locations within the groundwater target distance limit are recorded in the databases available at the Division of Geology and Land Survey. The LOGMAIN database contains information on older wells. The DGLS Well Wellhead Protection Section's Water Well Information System (W.I.M.S) database contains information on wells drilled since 1987. Additional information is available from the Public Drinking Water Program.Well, Missouri Department of Natural Resources, Division of Environmental Quality. Site locations are presented on Figure 4, and the corresponding well data is tabulated in Table 2. Some locations may be estimated or based on section centroids. The vast majority of the wells on record are domestic supply wells. Some wells may no longer be active. Many active wells may not be recorded in DGLS databases.

According to DEQ personnel and databases available at DGLS, one private well is located with ¼ mile of the Camdenton Sludge Disposal Area. 3 private wells are located with ¼ and ½ mile of the Former Hulett Lagoon Site. 2 wells are located between 0.5 and 1 mile of the site, including 1 community well and 1 private well. An additional 18 wells are located between 1 and 2 miles from the site, including 1 transient noncommunity well and 17 private wells. 30 wells are located between 2 and 3 miles from the site, 2 nontransient noncommunity wells and 28 private wells. 38 wells are located between 3 and 4 miles of the site including 2 community wells, 1 nontransient noncommunity well and 35 private wells.

Nearest Wells

It is likely that a large number of private wells in the area are not included in any DGLS database. The nearby wells mentioned here were located by DEQ personnel. The nearest well is located a few hundred feet west of the Camdenton Sludge Disposal Area at 3499 RR3 (County Road 5-120). Construction details for the well are not available.

Two private wells are located approximately ¼ mile southeast of the Camdenton Sludge Disposal Area. According to the owner, the well on the north side of County Road 5-

120, at 3496 RR3 was drilled in 1971 to a total depth of 528 feet with 40 - 45 feet of casing and the remainder open hole. Directly across the road from the 3496 RR3 residence is a third private well reported to have been drilled sometime between 1956 and 1958 to a total depth of 280 feet.
The nearest public drinking water supply well on record is Camden County Public Water Supply District #2 Well #1, known as the Camdenton Airport Well. The well is 848 feet deep and has 330 feet of casing. The well is illustrated on the Figure 2 cross-section. The Camdenton Airport Well is reportedly pumped only once per week. The Camden Co. PWSD #2 apparently obtains most of its water from Well #2, located approximately 3 miles south of the Camdenton Sludge Disposal Area.

SURFACE WATER PATHWAY

Hydrologic Setting

The Camdenton Sludge Disposal Area is situated near the crest of broad ridgetop that acts as the drainage divide between streams draining northwest, toward the Niangua Arm of the Lake of the Ozarks and streams draining east, toward the Dry Auglaize Creek. South and east of the site, unnamed streams flow southeast toward Forbes Branch. The natural landforms and drainage patterns at the site have been obscured by airport construction and soil disposal. The site itself has been leveled, while the surrounding terrain exhibits low natural relief (2% to 4% slopes). Land use patterns for the surrounding upland near the Camdenton Sludge Disposal Area include residential and agricultural properties with some light-industrial use. The steeper slopes are generally forested.

Rainfall Data

The average annual precipitation in the area of the Camdenton Sludge Disposal Area is slightly more than 37 inches. Average annual run-off is around 10 inches, and evapotranspiration amounts to about 28 inches per year; therefore, little precipitation is available for infiltration (Vandike, 1995). The 2-year, 24-hour rainfall for the area is about 3.5 inches (Rainfall Frequency Atlas, undated).

Surface Water Migration Path

Run-off from the Camdenton Sludge Disposal Area Site flows eastward toward Forbes Branch and Dry Auglaize Creek, both losing streams. Surface runoff would have to travel over 2.2 miles before reaching perennially-flowing water. Therefore, the potential to release by overland flow is not addressed in this document. Groundwater contamination is the main concern at the Camdenton Sludge Disposal Area Site.

Virtually all streams that have been evaluated near the Camdenton Sludge Disposal Area are losing. Losing streams include Forbes Branch, North Fork Linn Creek, and Racetrack Hollow. All are located less than 1 mile from the site. (Losing Stream File, 1999).

SURFACE WATER TARGETS

Drinking Water Intakes

No known direct intake of stream water is located within 15 downstream miles of the Camdenton Sludge Disposal Site (Missouri Public Water Systems, 1997).

SOIL / AIR PATHWAY

The Camdenton Sludge Disposal Site is now vegetated, and downstream or downwind receptors are not likely to be affected by the site itself.

The native soil in the vicinity of the Camdenton Sludge Disposal Area is the Lebanon silt loam (Wolf, 1994). Lebanon soils are deep, moderately well-drained soils typical of ridgetops. Permeability is moderate, although a shallow fragipan, if present, may perch water. Even if a fragipan is present, downward seepage is a potential concern.

The HRS Soil Group Designation from is C (Federal Register, 1990, Table 4-4).

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DEPARTMENT OF NATURAL RESOURCES
Division of Environmental Quality

TELEPHONE OR CONFERENCE RECORD

FILE: Camdenton Sludge Disposal Area | DATE: 8-11-17

TELEPHONE:	CONFERENCE:
Incoming ()	Field ()
Outgoing (X)	Office (X)

SUBJECT: Citizen concerns regarding TCE contamination in Camdenton Area

PERSONS INVOLVED:	REPRESENTING:
Keith Brown	MoDNR, HWP, Superfund
Tom Emry	City of Camdenton Public Works

SUMMARY OF CONVERSATION:
Mr. Emry was contacted by phone to discuss the disposal of sludge from Hulett lagoon and concerns about the possibility that an additional Camdenton Sewage treatment lagoon may have received industrial waste from Modine (Dawsons, Sudstrand).

Mr. Emry was asked whether he worked at the City (of Camdenton) when the sludge was removed from Hulett Lagoon and placed at the Camdenton Memorial Airport. "Yes' he replied. When asked if he knew of any other sites where Hulett lagoon sludge may have been taken he replied, "It all went to the airport….they 'dozed it in." He continued, "We dumped it at the end of the airport. I think the runway may have been extended over part of the area where it was dumped."

Mr. Emry explained that the City Public Works land applies their sludge. When asked if any of that sludge could have come from Hulett lagoon. He said "No, that was a separate operation. None of that sludge went anywhere else as far as I know." Mr. Emry mentioned that the lagoons that did not have sludge hauled away may have been closed in place with the berms turned in. He Stated "… but that was not what happened at Hulett Lagoon, it all went to the airport."

When discussing the waste in Hulett lagoon Mr. Emry said that it could contain elevated concentrations of copper and that a lot of the parts that Modine was manufacturing were little copper pieces of piping.

After being told that there were claims of additional lagoons containing waste from Modine, Mr.

Emry asked if there was a former City of Camdenton Employee that had complained. When he was told that we (the department) had spoken to a former employee he said “ I think I know who you are talking about….if it is the person that I think it is, I wouldn’t listen to him. He was a disgruntled employee.”

When asked if Modine waste was ever dumped into CP White Lagoon Mr. Emry Answered, “No, and it’s not possible unless you trucked it in. And if a truck came with industrial waste we wouldn’t take it.” Mr. Emry continued, saying,” There was no lift station at Hulett Lagoon. There is no way for it to get from there to here.”

Mr. Emry affirmed that he had no doubts that it would not have been possible to dump waste from Modine to any other lagoon than Hulett. He described the system gravity flow and uni-directional force mains that would not have allowed waste to flow in that direction. When asked if there were engineering plans describing the layout of the Camdenton Sewer System, Mr. Emry mentioned that there should be a copy at City Hall. Mr. Emry described how after Hulett lagoon was closed the lift pump was placed in another valley a ridge over from Hulett lagoon, but that this infrastructure did not exist at the time when Hulett Lagoon was closed.

Superfund Site Assessment Unit Chief — Date of Signature

Environmental Specialist — Date of Signature

Former Hulett Lagoon Site
Combined PA/SI
Reference 27

JOHN ASHCROFT
Governor

FREDERICK A. BRUNNER
Director

Division of Energy
Division of Environmental Quality
Division of Geology and Land Survey
Division of Management Services
Division of Parks, Recreation, and Historic Preservation

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES

DIVISION OF ENVIRONMENTAL QUALITY
P.O. Box 176
Jefferson City, MO 65102

May 26, 1988

The Honorable Mac Webster
Mayor of Camdenton
112 Court Circle, P.O. Box 1048
Camdenton, MO 65020

Re: IDG - 011 Camdenton, MO
Lagoon Closure

Dear Mayor Webster:

This letter is to explain what options are available for the City to pursue in order to completely abandon and close the Huelett or Factory Lagoon. We have reviewed the sludge sample analysis which your engineer sent to us on April 25, 1988 and May 20, 1988. The first step before you assess each option is to determine the percent moisture and the sludge depth at each sample site and to use the information to calculate the total weight of each of the various metals.

There are several options available to the City which are briefly explained below.

Option 1

Dispose of the sludge on site, at the lagoon. This option will require the preparation of a solid waste disposal area permit application complete with plans and specifications. The Waste Management Program would then review the application to determine if it could issue the permit. A point of contact for additional information and the time requirements of this option would be Mr. Tom Gredell at 751-3176.

Option 2

Haul sludge to a permitted, sanitary landfill. This would require a Special Waste Disposal Request. The sludge must also have no "free liquid" in order to be properly handled. A copy of the special waste disposal request form is enclosed. Tom Gredell would be your contact person as in option #1.

Option 3

Surface application in accordance with the Missouri Sludge Guide, "Agricultural Use of Municipal Wastewater Sludge" (Table 4).

The Honorable Mac Webster
May 26, 1988
Page 2

This would require the preparation and approval of a sludge management plan. The plan would limit the rate at which sludge could by applied. The rate would be based upon limiting the weight of metals to be applied to allow the unrestricted use of the land in the future. You should contact Ken Arnold at 751-6624 for additional information.

Option 4

Sub-surface application at the maximum one time rate. This would require either injecting the liquid sludge with chisel plows under the soil surface, or spreading the sludge, discing and then plowing the field. The rate of application would be higher than in option #3, but could not exceed the maximum cumulative site loadings per the Sludge Guide. This option would require the site to be City owned and the site would be restricted for use as a sludge disposal site in the future. Ken Arnold would be your contact person as in option #3.

Please note that what ever option is used, the lagoon must not discharge to the creek unless the City receives a new operating permit. The lagoon currently doesn't have a discharge permit. Preferably, any discharge would be to the City's sewer and be tested for compliance with the City's pretreatment ordinances before being introduced to the sewer.

We suggest you work closely with your engineer to quickly resolve the fate of the sludge disposal and lagoon abandonment. Please note the grant cannot be closed and final reimbursement made until this work is complete. If you should have any questions, please do not hesitate to call me at 751-6619.

Sincerely,

WATER POLLUTION CONTROL PROGRAM

Dave Freise

David Freise, P.E.
Project Engineer

DF/pa

cc: Jefferson City Regional Office
Missouri Engineering Corporation

Former Hulett Lagoon Site
Combined PA/SI
Reference 28

JOHN ASHCROFT
Governor

G. TRACY MEHAN III
Director

Division of Environmental Quality
Division of Geology and Land Survey
Division of Management Services
Division of Parks, Recreation, and Historic Preservation

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES

DIVISION OF ENVIRONMENTAL QUALITY
P.O. Box 176
Jefferson City, MO 65102

November 2, 1989

The Honorable Mac Webster
Mayor of Camdenton
112 Court Circle, P.O. Box 1048
Camdenton, MO 65020

Re: IDG-011 Huelett Lagoon

Dear Mayor Webster:

I recently visited the above referenced lagoon site and the temporary sludge storage site at the city airport. During my visit, I noted a berm was not yet in place around the temporary storage to prevent solids run off. This is a condition of the approval issued February 22, 1989. The city administrator, Kent Hixson, stated the berm would be in place as soon as possible.

I would also like to remind you the approval is valid for only one year. Therefore, the sludge spreading must be completed in accordance with the plan and approval letter by February 22, 1990.

Thank you for your consideration in these matters and please thank Kent Hixson for me for the time he spent with me that day.

Sincerely,

WATER POLLUTION CONTROL PROGRAM

Dave Freise

David Freise, P.E.
Project Engineer

DF:mle

cc: Jefferson City Regional Office
City Administrator, Kent Hixson
Missouri Engineering Corporation

From:	Hartman, Michelle
To:	Brown, Keith
Cc:	Stroh, Michael; Wambuguh, Dennis; Wenzel, Jeff
Subject:	RE: Hex chrome screening levels in Missouri
Date:	Friday, May 25, 2018 2:36:47 PM

Keith – The 2017 DHSS letter you attached was for the site I mentioned previously in my email. However, again since we have not yet put together our technical write-up justifying the use of an alternate screening value, we cannot recommend other sites use that number at this time. Also, we would prefer you not use the 0.4 ppb level mentioned below that is referenced in the 2010 MDNR factsheet. We would recommend simply including a discussion in the report about how the results compare to the current RSLs and how the science is still under review like you mention below. If you'd like in the report, you could specifically mention that hex chrome toxicity is currently under review by MDHSS.

Also, not sure if you've seen this link, but perhaps this may also be helpful to include a brief discussion of EPA's review to determine whether a new drinking water regulation for hex chrome or a revision to the current total chromium standard is warranted:
https://www.epa.gov/dwstandardsregulations/chromium-drinking-water

Michelle

Public Health: Better Health. Better Missouri.

****
Michelle D. Hartman, Environmental Specialist
Bureau of Environmental Epidemiology
Division of Community and Public Health
Missouri Department of Health and Senior Services
930 Wildwood Drive, P.O. Box 570
Jefferson City, MO 65102-0570
(573) 751-6102
Michelle.Hartman@health.mo.gov

From: Brown, Keith
Sent: Friday, May 25, 2018 12:11 PM
To: Hartman, Michelle <Michelle.Hartman@health.mo.gov>
Cc: Stroh, Michael <michael.stroh@dnr.mo.gov>
Subject: RE: Hex chrome screening levels in Missouri

Hi Michelle,

No problem, I know you all are busy too. I had a feeling the levels were still in flux. Michael Stroh recently came up with a 2017 document (letter) from MDHSS recommending a hex chrome cleanup level of 46 ug/L (listed as 0.046 mg/L in table)for what is I believe a brownfields site. I attached that document here- it seems like a pretty high number, but it is the latest semi-official recommendation that we have from MDHSS at this time. We thought that we could perhaps apply that number to the Camdenton Sludge Disposal Area site at least for comparison purposes.

Otherwise, another 2010 MDNR factsheet that Michael found recommends no greater than 0.41 ug/L hex chrome in drinking water – I also attached that document. I think unless you all finalize a recommendation before my report is completed I will include a discussion about how the results meets or fails the various standards and how the science is still under review. I only had one result over the EPA 1X10^{-6} level anyhow – The backup public well had 0.31 ug/L hex chrome, but it is not in regular use and only had 3 or 4 ug/L total chromium.

Thanks,

Keith Brown
Environmental Specialist
Site Assessment Unit, Superfund Section
Missouri Department of Natural Resources
Hazardous Waste Program
P.O. Box 176 Jefferson City, MO 65102-0176
Phone 573 526-3287/Fax 573 751-7869
We'd like your feedback on the service you received from the Missouri Department of Natural Resources. Please consider taking a few minutes to complete the department's Customer Satisfaction Survey at https://www.surveymonkey.com/r/MoDNRsurvey . Thank you.

From: Hartman, Michelle
Sent: Friday, May 25, 2018 11:26 AM
To: Brown, Keith
Cc: Hartman, Michelle; Wambuguh, Dennis; Stroh, Michael; Kator, Martin
Subject: RE: Hex chrome screening levels in Missouri

Keith – Sorry I did not get back to you sooner on this. So, essentially the levels are still in flux at this time. Right around the time you all were doing this sampling, as part of an assessment for another site, the toxicity of hex chrome was challenged by the other site's PRP. At the federal level this has been and is still being challenged, but no final determination has been made. With the controversy surrounding hex chrome toxicity and no final determination at the federal level, we had to make a decision for the site we were working on, so we sought out an independent evaluation by an outside toxicologist. Through that independent review, we made a determination that the site cleanup values proposed using alternate toxicity values for hex chrome were health-protective. Our intention is to put together a technical document on hex chrome toxicity and our determination; however, we have not completed that yet; therefore, we cannot provide an alternate screening level

for use at this time.

I would recommend using the EPA RSLs for now. Yes, a few of the wells exceed the EPA RSL at a 10^{-6} cancer risk, but that is not a level at which actions would typically be taken, so I think this could be explained in the text. If you need to discuss with us or for us to review the draft report or text, just let us know.

Michelle

Public Health: Better Health. Better Missouri.

****
Michelle D. Hartman, Environmental Specialist
Bureau of Environmental Epidemiology
Division of Community and Public Health
Missouri Department of Health and Senior Services
930 Wildwood Drive, P.O. Box 570
Jefferson City, MO 65102-0570
(573) 751-6102
Michelle.Hartman@health.mo.gov

From: Brown, Keith
Sent: Thursday, May 17, 2018 10:43 AM
To: Hartman, Michelle <Michelle.Hartman@health.mo.gov>
Cc: Stroh, Michael <michael.stroh@dnr.mo.gov>; Kator, Martin <martin.kator@dnr.mo.gov>
Subject: Hex chrome screening levels in Missouri

Hello Michelle,

I have some hexavalent chromium sample results from the Camdenton Sludge Disposal Area and I was wondering if there is a current State of Missouri screening level that I can use. My recollection is that these regulations are somewhat in flux, so even the latest recommendation for hex chrome would be helpful.

As a quick update- Last fall we collected hex chrome samples from the Camden County public well (PWSD# 2 well 1)near the airport close to where the sludge was buried and two background wells in Camdenton. The hex chrome sampling was initiated because we outlined in the sampling plan that it would be collected if a well had over 3.5 ug/L total chromium. The county well had 3.25 ug/L Cr and

then 4.41 ug/L Cr over the two sampling events so we went ahead and ran it through the contract lab to comply with the SAP.

Just to be clear the County well is a backup well that is rarely, if ever, used. I attached a draft excel spreadsheet with the Cr6 sample results. The contract lab Hex chrome result for the County well was 0.31 ug/L and the background wells had 0.013 ug/L and 0.081 ug/L respectively. I don't think any of these seem too high, but I noticed that the county well and one of the background wells exceeds the EPA screening level of 0.035 ug/L Cr6.

Anyhow, I just wanted to update you with these results and see if there is a Cr6 screening level recommended by MDHSS that I can include in my report.

Thanks,

Keith Brown
Environmental Specialist
Site Assessment Unit, Superfund Section
Missouri Department of Natural Resources
Hazardous Waste Program
P.O. Box 176 Jefferson City, MO 65102-0176
Phone 573 526-3287/Fax 573 751-7869

Former Hulett Lagoon Site
Combined PA/SI
Reference 33

City of Camdenton

112 Court Circle P O Box 1048
Camdenton MO 65020
314-346-3600

Ronnie Testerman
Department of Natural Resources
P O Box 176
Jefferson City, Mo 65102

April 9, 1990

RE Hulett Lagoon Sludge Disposal
    Work Completion Summary

Dear Ronnie,

As per the approved sludge disposal plan for this project, I am submitting to DNR a work completion summary The following is a chronological recounting of the events surrounding the project

January 1989 The fields at the airport were limed in order to improve the pH levels to 6

June, July, August 1989 The contractor mixed the sludge with lime in the lagoon and transported it to the storage site at the airport Rain delays and traffic considerations added to the length of time needed for this work

December, 1989 After allowing it to dry, the contractor began spreading the material via dry sludge applicator on the designated fields at the airport, mixing it with additional soil and discing the sludge into the ground Soils tests were taken to insure the loading rate did not exceed set limits Rain and snow delayed completion of the spreading

March, 1990 Mixing, spreading and discing were completed Soils test were taken and demonstrated that the loading was below the specified levels The fields have been seeded with a mix of Timothy and Fescue grasses in order to provide ground cover and prevent erosion

April, 1990 The fields that are below a pH level of 6 will be limed to bring them up as needed

I hope that this summary statement fulfills the requirements of the approved sludge disposal specifications Should you have any questions or require further information, please feel free to contact me

Your cooperation and assistance in helping the city is very much appreciated

Sincerely,

Kent L Hixson

Kent L Hixson

Former Hulett Lagoon Site
Combined PA/SI
Reference 34

City of Camden
112 Court Circle P O Box 1048
Camdenton MO 65020
314-346-3600

Mr Paul Kieler
Jacobs Engineering Group
10901 W 84th Terrace
Suite 210
Lenexa, Kansas 66214

March 23, 1992

RE Hulett Lagoon Clousre Process

Dear Mr Kieler,

Enclosed are some documents relevant to the closing of Hulett Lagoon This is the sewer lagoon that Modine, formerly Sunstrand, discharged into The lagoon was built in 1962-63 and was taken out of service in 1986-87 after Sunstrand constructed the pre-treatment facility

The actual lagoon closure wasn't completed until late 1989 I had only recently been hired by the City and was not involved in the development of the closure plan

I do know that all the sludge was taken to the municipal airport and land applied then tilled into the soil according to the DNR guidelines The berms of Hulett lagoon were turned in and mixed with on a 1 to 1 ratio

The City is in the process of leveling off the site and opening it up for a neighborhood park

If you have any questions or require further information, please feel free to contact me

Sincerely,

Kent L Hixson

Kent L Hixson
City Administrator

JOHN ASHCROFT
Governor

FREDERICK A. BRUNNER
Director

Division of Energy
Division of Environmental Quality
Division of Geology and Land Survey
Division of Management Services
Division of Parks and
Historic Preservation

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES

DIVISION OF ENVIRONMENTAL QUALITY
Jefferson City Regional Office
1001A Southwest Boulevard
P.O. Box 176
Jefferson City, MO 65102
314-751-2729

June 20, 1986

1.720 Camdenton

Ms. Trudy Marco
Grants Coordinator
City Hall
P.O. Box 399
Camdenton, MO 65020

Dear Ms. Marco:

Enclosed is the report and checklist from the audit of your approved Pretreatment Program implementation, as conducted by Leora M. Reising of my staff. If you have any questions concerning this report please call Leora M. Reising or Jerry Croy at (314) 751-2729.

Sincerely,

JEFFERSON CITY REGIONAL OFFICE

B.R. Kesler
Regional Administrator

BRK/LR/ko

Enclosure

cc: Water Pollution Control Program, Attn: Rich Kuntz

JOHN ASHCROFT
Governor

FREDERICK A. BRUNNER
Director

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES

Division of Energy
Division of Environmental Quality
Division of Geology and Land Survey
Division of Management Services
Division of Parks and
Historic Preservation

DIVISION OF ENVIRONMENTAL QUALITY
Jefferson City Regional Office
1001A Southwest Boulevard
P.O. Box 176
Jefferson City, MO 65102
314-751-2729

June 20, 1986 1.720 Camdenton

D. Roger Elder
City Administrator
City Hall
P.O. Box 399
Camdenton, MO 65020

Dear Mr. Elder:

Enclosed is the report and checklist from the audit of your approved Pretreatment Program implementation, as conducted by Leora M. Reising of my staff. If you have any questions concerning this report please call Leora M. Reising or Jerry Croy at (314) 751-2729.

Sincerely,

JEFFERSON CITY REGIONAL OFFICE

BRKesler

B.R. Kesler
Regional Administrator

BRK/LR/ko

Enclosure

cc: Water Pollution Control Program, Attn: Rick Kuntz

Pretreatment Compliance Audit
City of Camdenton
NPDES Permit Numbers
C.P. White - MO-0048569
Dump - MO-0048585
Hulett - MO-0048577
Wilkerson-Clint - MO-0048607
Parish - MO-0048593

June 20, 1986

On April 15, 1986 an audit was conducted of the Industrial Pretreatment Program as implemented by the City of Camdenton, Ms. Trudy Marco and Mr. D. Roger Elder represented the city and Ms. Leora M. Reising represented the Missouri Department of Natural Resources.

The City of Camdenton received approval to implement the Industrial Pretreatment Program on September 26, 1983 by the Missouri Department of Natural Resources. The City of Camdenton operates five lagoons. However, only one lagoon is of interest to the Industrial Pretreatment Program, that is the Hulett (a.k.a. Factory) lagoon.

FINDINGS:

The City of Camdenton has jurisdiction over their entire collection and treatment system. They operate five lagoons,only one receives an industrial waste. The Hulett lagoon receives the waste from Sunstrand Tubular Products, Inc.

Sunstrand Tubular Products, Inc. is a manufacturer of aluminum and copper components and heat transfer coils for air conditioners, used in homes, automobiles, and various industries. The manufacturing process consists of aluminum and copper cutting and brazing, aluminum etching, and a small amount of chromium electroplating They have installed a pretreatment system to remove heavy metal components from their wastewater primarily from the aluminum etching process. The system was finished prior to the pretreatment audit but the reagent tanks were still being filled so it was not in operation.

The City of Camdenton has not developed their sampling, inspection, and permitting procedures. They need to address a variety of topics in their pretreatment program. An increase in personnel familiar with pretreatment and/or sampling and tracking procedures would be helpful. Parts of the program could be contracted to consultants.

The city personnel involved have been very conscientious but they are working with a handicap of not enough time and resources.

RECOMMENDATIONS:

1. Establish, document, and implement formal sampling procedures.

2. Pursue enforcement actions as specified by the federal pretreatment regulations.

3. Establish local limits with regards to production rates, method of waste treatment, method of sludge disposal, and NPDES discharge limits.

4. Have adequate personnel available or on contract for sampling, analyzing, monitoring, tracking, and enforcing the pretreatment program.

5. Up-date city ordinances and policies with any changes in the federal pretreatment program.

6. Submit all changes of your sewer use ordinance and pretreatment program to the Department of Natural Resources for approval.

Should you have any questions please call the Jefferson City Regional Office at (314) 751-2729.

Submitted By:

Leora M. Reising
Environmental Specialist

Approved By:

B.R. Kesler
Regional Administrator

LR/ko

Enclosure

INSPECTED BY Leora M. Reising DATE OF AUDIT 9/15/86

POTW PRETREATMENT PROGRAM AUDIT

1. General Information
   - (A) NAME OF PERMITTEE: CITY OF CAMDENTON (B) NPDES # MO-0048577
   - HULETT (AKA. FACTORY)
   - (C) MAILING ADDRESS: CITY HALL
     P.O. BOX 399
     CAMDENTON MO 65020
   - (D) POTW ADDRESS: NONE
   - (E) POTW REPRESENTATIVE: D. ROGER ELDER
   - (F) TITLE: CITY ADMINISTRATOR
   - (G) TELEPHONE NO: (314) 346-3600
   - (H) PRETREATMENT PROGRAM APPROVAL DATE: 9/26/83
     PREVIOUS PRETREATMENT AUDIT: __/__/__ NONE

2. POTW Information
   - (A) DESIGN DRY WEATHER FLOW 26,500 GD ~~(mgd)~~
   - (B) AVERAGE ANNUAL FLOW ____ (mgd)
   - (C) PERCENT INDUSTRIAL FLOW UNKNOWN %
   - (D) SEWER SYSTEM: SEPARATE X COMBINED ____
   - (E) LEVEL OF TREATMENT: TYPE: LAGOON
     - Primary............... __
     - Secondary............. X
     - Advanced Secondary..... __
     - Tertiary.............. __
   - (F) METHOD OF SLUDGE DISPOSAL: NOT APPL.

3. Summary of Program Evaluation

	(S)	(U)	(R)	N/A
(A) Legal Authority	X			
(B) Local Limits			X	
(C) Inspection and Monitoring Procedures			X	
(D) Control Mechanism and Enforcement			X	
(E) POTW Records and Public Participation			X	
(F) Program Resources			X	

(S) - Satisfactory (U) - Unsatisfactory

(R) - Revisions to Program Needed

LEGAL AUTHORITY

	Yes	No	N/A
1. POTW Jurisdiction			
(A) Are all industrial contributions within the POTW's jurisdiction......................	X		
(B) Is this jurisdictional situation as documented in the approved pretreatment program...........	X		
If not, have legal agreements/contacts been entered into with new jurisdictions...........			X
(C) Are exiting pretreatment agreements with contributing jurisdictions proving to be effective for regulating IUs in those jurisdictions..............................			X

COMMENTS:

2. Sewer Use Ordinance (SUO)

	Yes	No	N/A
(A) Is the current SUO identical to that in the approved pretreatment program.................	X		
If not, were revisions approved by the State			

If not, did unapproved changes occur to sections on:

- o General Prohibitions....................... ___
- o Specific Prohibitions...................... ___
- o Local Limits................................ ___
- o Categorical Standards....................... ___
- o Control Mechanisms......................... ___
- o Inspection, Surveillance & Monitoring........ ___
- o Compliance & Enforcement.................... ___
- o Confidentiality Requirements................ ___
- o Special Agreements/Waivers.................. ___

COMMENTS:
A new SUO is being prepared.

	(S)	(U)	(R)
3. Summary Evaluation of Legal Authority			
COMMENTS:	X		

LOCAL LIMITS

1. Status

	Yes	No
(A) Does the POTW have local limits	X	
If yes, are local limits technically based		X
(B) Do local limits exist for:		
BOD	X	
TSS	X	
Ammonia		
Cadmium		
Chromium (T)	X	
Chromium (VI)	X	
Copper	X	
Cyanide		
Mercury		
Nickel		
Silver		
Zinc	X	
Phenols		
Chlorinated Hydrocarbons (T)	X	
Other		

If yes specify oil & grease

	Yes	No
(C) Are removal credits employed		X
(D) If there is more than one POTW treatment plant, are the local limits established specifically for each plant		X

only for Hewlett

COMMENTS:

2. Categorical Industries

(A) Number of industries affected by Categorical Standards	1	
(B) Number of industries using the combined waste stream formula	0	
(C) Number of industries with production based limits	0	
(D) Are there categorical industries in the system for which the categorical standard is more stringent than the locally established limits		X
If yes: Is the more stringent limit in the control mechanism		

COMMENTS:

3. Effectiveness of Local Limits

(A) Is POTW consistently meeting NPDES limits.... ___ X

(B) Has the POTW been free from industrial inhibition/upsets.......................... ___ X

(C) Are water quality standards being met........ unknown

(D) Has the POTW been free of sludge contamination problems...................... ___ X

(E) Has toxicant sampling of POTW influent, effluent and sludge been conducted during the last year............................. ___ X

(F) Does the POTW conduct biomonitoring analyses of the effluent.................... unknown

COMMENTS:

4. Summary Evaluations of Local Limits

(S)	(U)	(R)
___	X	___

COMMENTS:

Sunstrand installed its pretreatment equipment and had it operating this spring (April & May)

INSPECTION AND MONITORING PROCEDURES

1. General

(A) How many facilities were inspected in the last year.................................... 1 100%

(B) How many facilities were sampled in the last year.. 0 0%

(C) What percentage of inspections were announced.. 0 %

(D) What percentage of sampling visits were announced.. N/A %

COMMENTS:

2. Procedures

	Yes	No
(A) Are formal sampling and inspection procedures established..............................		X
(B) Are inspectors provided with safety equipment	X	
(C) Are samples split with industry personnel....	N/A	
(D) Are all samples properly preserved...........	N/A	
(E) Are chain-of-custody procedures employed.....	N/A	
(F) Do all analyses conform to EPA methodologies.	N/A	
(G) Is there a QA/QC program for sample analyses.	N/A	

COMMENTS: The city has not taken samples at Sundstrand.

3. Summary Inspection and Monitoring Evaluation

	(S)	(U)	(R)
COMMENTS:			X

CONTROL MECHANISM AND ENFORCEMENT

Indicate the type(s) of control mechanism employed:

Permit System	___
Contracts	___
Sewer Use Ordinance	X
Other	___ Specify: ___

1. Control Mechanism

	Yes	No	N/A
(A) Is the control mechanism as described in the approved program	X		
(B) Are all significant industrial users regulated through the control mechanism			X
(C) Are permits/contracts:			
o For a limited duration			X
o Non-transferrable			X
o Revocable			X
o Able to be modified			X
(D) Do permits/contracts:			
o Contain local limits			X
o Contain categorical standards			X
o Contain compliance schedules			X

COMMENTS:

2. Noncompliance and Enforcement

(A) How many categorical industrial users (CIUs) were found to be out of compliance with local or categorical discharge limits (whichever is more stringent) during the past year	1		
How many of these CIUs regained compliance during the same period of time	0		
(B) How many significant industrial users (SIUs) were found to be out of compliance with local discharge limits during the past year			N/A
How many of these SIUs regained compliance during the same period of time			N/A

(C) List enforcement actions taken to bring violators into compliance.

Administrative	Yes	No	How many times
o Verbal warning	X		
o Written warning	X		
o Notice of violation letter		X	
o Compliance schedule		X	
o Revoke permit		X	
o Termination of service		X	
o Other (specify) ______		X	

Legal	Yes	No	How many times
o Consent decree		X	
o Civil penalties		X	
o Criminal penalties		X	
o Injunctive relief		X	
o Other (specify) ______		X	

(D) How many IUs are currently operating under a compliance shcedule to correct discharge violations.................................... 1

(E) What percentage of all IUs regulated under the POTW pretreatment program are in compliance with pretreatment standards at the present time 0

COMMENTS:

3. Summary Control Mechanism & Enforcement Evaluation (S) (U) (R)

COMMENTS: ___ ___ X

POTW RECORDS AND PUBLIC PARTICIPATION

1. Industrial Waste Survey (IWS)

		Yes	No
(A)	Is the IWS periodically updated..................		X
(B)	Have all new industrial discharges been adequately characterized........................	X	
(C)	Have any industries been removed from the list of significant dischargers..................		X

COMMENTS:

2. Report Review & Analysis

		Yes	No
(A)	Are inspection and sampling records well organized and readily retrievable................	X	
(B)	Are sampling results checked against discharge standards..	N/A	
(C)	Are appropriate actions taken in response to problem monitoring reports......................	N/A	
(D)	Are all records maintained for 3 years...........	X	

COMMENTS: No sampling has been done

3. Industrial Reporting

		Yes	No
(A)	Has the POTW required self-monitoring reports from industrial users in accordance with categorical standards............................	X	
(B)	Has the POTW required submission of baseline monitoring reports...............................	X	
(C)	Are self-monitoring reports and BMR verified by field inspections..............................	X	

COMMENTS:

4. Public Participation

	Yes	No	N/A
(A) Did the POTW publish an annual notice of violators in local newspapers....................		X	
(B) Are all program records available to the public..	X		
(C) Has public comment been solicited during revisions to the SUO and or local limits.........	X		

COMMENTS:

5. Summary POTW Records and Public Participation Evaluation

	(S)	(U)	(R)
COMMENTS:			X

PROGRAM RESOURCES

1. Manpower

	Yes	No
(A) Are adequate personnel provided in the following areas:		
o Sampling		X
o Sample analyses	N/A	
o Inspection		X
o Administration	X	
o Legal	X	
o Technical Review		
(B) Do available personnel have appropriate training		X
(C) Is a commercial lab used		

If yes, for what analyses: ______________________

COMMENTS:

2. Equipment

	Yes	No
(A) Is adequate sampling equipment available		
(B) Is adequate safety equipment available		
(C) Are an adequate number of vehicles available		
(D) Is the analytical lab adequately equipped		

COMMENTS:

3. Funding

	Yes	No
(A) Is the program adequately funded		
(B) Is funding expected to continue at an adequate level		

COMMENTS:

4. Summary Evaluation of Resources

(S)	(U)	(R)
		X

COMMENTS:

Former Hulett Lagoon Site
Combined PA/SI
Reference 32
10/20/89

Mr. Hixson & Council Members:

This letter is in regard to the cost overrun involved in the Hulett Lagoon Project.

I was in constant contact with Missouri Engineering at all stages of the job. There was an inspector on the job at all times. Missouri Engineering was well informed of all additional work necessary to complete the job, including additional pumping, extra lime & more sludge to be removed than Missouri Engineering's estimate. I was assured it was not a problem because I was to be paid by the yard for the removal.

I also want to add that I was told that if there was less than 1500 yards of sludge, I would be paid less. If there was more, I would be paid more. I accepted both possibilities as I assumed the council did

As you all know, the weather posed a problem, with an unusual frequency of rainfall. This was no one's fault but it did not allow the sludge to shrink down as it dried the way it should have This kept the bottom of the lagoon soft, making it impossible to prevent getting a small amount of

mud along with the sludge. At no time was more removed than was absolutely necessary in order to get all the sludge out.

At the bid opening for this job, I said in the presence of Mr. Ray, the mayor & the past city administrator that I knew there was a lot more than 1500 yards of sludge in there. The yardage was discussed with Missouri Engineering numerous times and I was always assured it was no problem.

My bid was quite fair. I did not "create" an overrun for my benefit. It would have been to my benefit if there had been only 1500 yards.

The prices I submitted for spreading the sludge, I believe you will also find very reasonable. But, again, all prices are unit prices.

I will attend the November 7 meeting & hope to help clear up any questions as best I can.

Sincerely,

Ron McCormick

Sundstrand

Former Hulett Lagoon Site
Combined PA/SI
Reference 35

PRELIMINARY ASSESSMENT
SUNDSTRAND
CAMDEN COUNTY, MISSOURI

January 31, 1992

Missouri Department of Natural Resources
Hazardous Waste Program

Prepared By:	Reviewed By:	Approved By:
John Madras	Jim Belcher	Ed Knight
John Madras, Environmental Specialist	Jim Belcher, Chief, Planning and Pre-Remedial Unit	Edwin D Knight, Chief, Superfund Section

Date: January 31, 1992

Prepared by: John Madras
Missouri Department of Natural Resources

Site: Sundstrand
City of Camdenton, Camden County, Missouri

EPA ID No.: MOD

1. INTRODUCTION

Under the authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Missouri Department of Natural Resources, through a cooperative agreement with the U.S. Environmental Protection Agency, conducted a Preliminary Assessment (PA) at the Sundstrand site. The purpose of this investigation was to collect information concerning conditions at the site sufficient to assess the threat posed to human health and the environment, and to determine the need for addition investigation under CERCLA/SARA or other action. The scope of this investigation included review of available file information, a comprehensive source survey, a comprehensive target survey, and an on-site reconnaissance.

2. SITE DESCRIPTION, OPERATIONAL HISTORY, AND WASTE CHARACTERISTICS

2.1 Location

The Sundstrand site is located in the City of Camdenton, Missouri, at the center of Camden County, Missouri (Figure 1). The geographic coordinates are 38° 00′ 32.5′′N latitude and 92° 45′ 26′′W longitude (Reference 1). The site is located about one-half mile west of the intersections of U S. Route 54 and Missouri Route 5/7. The site can be accessed by turning west onto Sunset Drive from Missouri Route 5/7.

Camden County is characterized by a temperate climate. Summers are warm and humid with daily temperatures reaching 90°F or higher. The winter months are generally cold with normal daily temperatures of 22° to 42°F. Net annual precipitation for the area is 42 inches (Reference 2, pages 1, 13, 43).

2.2 Site Description

The suspected area of contamination includes soil beneath the manufacturing facility, and soil and fill material comprising loading areas and parking lot adjacent to the facility on the west (Reference 3,4) Trichloroethylene (TCE) and 1,1,1-trichloroethane (TCA) have been detected in the soil below the facility and in borings in the adjacent areas outside of the facility (Reference 5) Groundwater may be affected.

Concentrations of TCE and TCA detected at the facility are shown on Figure 2 (from Reference 5)

The facility is located on a gently, sloping terrain which drops steeply toward a permanently flowing tributary of Lake of the Ozarks.

The Sundstrand site appears to be the sole source of potential TCE or TCA contamination in the vicinity of the site itself. Other potential sources are present in the Camdenton area (Reference 6; Electrovert USA site).

Sundstrand was an interim status hazardous waste treatment, storage, and disposal facility (EPA ID# MOD06249351). The Department requested a Part B application to be submitted. The facility was sold to Modine Heat Transfer, Inc , a wholly owned subsidiary of Modine Manufacturing Company. The new owner stated their intention to complete the closure begun by Sundstrand and operate the facility as a "generator only" facility (Reference 7).

Wastewater from the facility was discharged to the City of Camdenton sanitary discharge system. At the time of the alleged release, that discharge was delivered to the City's "Factory" lagoon. This lagoon was subsequently closed and discharges were transferred to the City's new wastewater treatment facility

2.3 Operational History and Waste Characteristics

To date, no governmental agencies have conducted sampling at this site. Routine water well sampling has been conducted for the City of Camdenton wells, the closest of which is about 200 feet from the site. No contamination was detected (Reference 8).

Modine Heat Transfer, Inc., the present owner and operator of the facility, expressed an interest in conducting sampling following a meeting with the Department of Natural Resources on March 11, 1991 (Reference 9). A sampling plan was submitted; however, it was not approved (Reference 10).

After one revision of the plan, the owner decided to proceed without approval by the Department (Reference 11). Sampling was conducted October 5-8, 1991, without approval of the plan or oversight of the sampling by the U S Environmental Protection Agency or the state.

No removal actions or other response actions have occurred at the site.

3 GROUNDWATER PATHWAY

3.1 Hydrogeologic Setting

The following information is reported from the Missouri Division of Geology and Land Survey (Reference 12)

The bedrock at the site is the Roubidoux Formation The surficial materials developed overlying the bedrock are composed of stratified layers of hard, broken chert and sandstone fragments in red, silty clay

Beds of massive boulders, some over three feet thick are not uncommon This residuum is three to nine feet thick

The area is underlain by a thick sequence of Ordovician and Cambrian aged rocks The sequence is primarily dolomite, and may be up to 1,800 feet thick The section that includes the principle aquifers through the Potosi Dolomite is uninterrupted by a consistent confining bed This part of the section is approximately 1,000 feet thick, and is made up of dolomites except for the Roubidoux Formation, which contains intervals of dolomitic sandstone, and the Gunter Sandstone Member of the Gasconade Dolomite Though some units in this sequence may act as relative confining layers, the entire section from the Potosi Dolomite up through the Roubidoux formation should be considered one aquifer

The Davis Formation contains the only persistent confining shale bed in the section It serves as a boundary between the lower part of the Cambrian sequence, and the Potosi and stratigraphically higher formations Vertical circulation of water has enlarged openings along joints and fractures, allowing freer passage of water from the surface through the Potosi Dolomite

There are no major geologic structures in the target area to constitute an aquifer discontinuity There are also no topographic features which transect an aquifer within the target area

The aquifer underlying the site is a karst aquifer Karst features are particularly well developed in the Roubidoux Formation, which is the uppermost bedrock beneath the site Segments of the unnamed stream downgradient from the site are losing

3 2 Groundwater Targets

The majority of the population within a 4-mile radius relies on public water supplies, either the City of Camdenton or one of the other public water supplies The Camdenton public water supply is a blended system that draws water from three wells All three wells are within one mile of the site, and together they serve the population of 2,561 (Reference 13) Sampling of the City of Camdenton wells in 1987 and 1991 did not detect contamination by the hazardous substances of concern at this site (Reference 8)

In addition, there are many other public water supply wells located in the vicinity of the site, including the wells for the City of Linn Creek (see Table 1) There are approximately 374 homes within four miles which use private wells for drinking water (Reference 1) At 2 4 persons per household (the average for Camden County, Reference 14), this equates to 898 residents

The residence using a private well and located closest to a suspected source of the contamination is about 3,700 feet from the western side of the Modine plant. No residences relying on private wells are located within a 0.25-mile radius of this potential source (Reference 1).

All water wells in the area produce from the same aquifer. Most of the lake homes, restaurants, condominiums, and subdivisions have private water supplies, as there are no rural water districts in the area. There is no wellhead protection area in the vicinity of the site.

3.3 Groundwater Conclusions

A release of hazardous substances to the Cambro-Ordovician aquifer is possible through the on-site disposal of solvents. TCE has been detected in area springs in the vicinity of the site, although dye trace work in the Camdenton areas has not been successful in identifying the recharge area of the spring. Due to the relatively high conductivity of the aquifer, potential widespread migration of contaminants is high. There are no residents whose wells are within 0.25 mile of the potential source. TCE and TCA are very mobile contaminants and the direction of groundwater flow is unknown. As no well contamination has been detected in wells close to the site, the remainder of residents dependent upon private wells within four miles are considered to be secondary targets.

4. SURFACE WATER PATHWAY

4.1 Hydrologic Setting

The site is located near the divide between two small branches of an unnamed stream which drains west to the Niangua Arm of the Lake of the Ozarks. Water appears to run off the site to the south and southwest. There are no runoff containment structures on-site. Discharge from the drainage pipe on the west side of the parking lot runs through an excavated area and into a well defined gully west of the site The two drainage pipes on the south side of the facility do not appear to ever discharge large quantities of water since there is no channel leading from the pipe. The site is less than one-half mile southwest of the divide between the Linn Creek drainage and the Niangua River drainage. The two-year 24-hour rainfall for the site is 3.5 inches.

Drainage from the site flows overland to the south and southwest down a steep slope for approximately 700 feet before it enters an unnamed stream, which flows southwest to the Lake of the Ozarks. This unnamed stream contains losing segments The drainage area of the site is less than 50 acres The site is not located in a floodplain

Since this is a karst area, water issuing from springs within the groundwater target area should be considered for the surface water pathway. This would

include Ha Ha Tonka Spring and an unnamed spring near the City of Linn Creek TCE has been previously detected in Ha Ha Tonka Spring

4 2 Surface Water Targets

The unnamed tributary is a permanently flowing water body at the probable point of entry of contaminants from the site (Reference 1) This tributary is not a classified stream in the Missouri Water Quality Standards It is subject to the general criteria for protection of all waters of the State of Missouri (Reference 15, page 11) Lake of the Ozarks, into which this unnamed creek flows, is classified for the protection of livestock and wildlife watering, the protection of warm water aquatic life and human health/fish consumption, whole body contact recreation, and boating and canoeing (Reference 15, page 32)

There are no identified drinking water intakes in the vicinity of the site

There are no identified wetlands in the vicinity of the site There are sensitive environments present in the vicinity of the site (References 16, 17), although they do not occur in surface waters

4 3 Surface Water Conclusions

There are no present indications that hazardous substances have been released into surface waters or into areas that drain toward permanently flowing surface waters The waters of the unnamed tributary appear to be recharged at least partially from shallow groundwater, which is suspected to be contaminated There are no water intakes located on the tributary or on the Lake of the Ozarks No identified wetlands are present in the vicinity of the site A federally designated endangered species, as well as other sensitive environments, are present in the vicinity of the site Primary targets include the fisheries of the tributary and Lake of the Ozarks, and the sensitive environments

5 SOIL EXPOSURE AND AIR PATHWAYS

5 1 Physical Conditions

At this point, no areas of surface soil contamination have been identified Hazardous substances have been detected at shallow depths in parking areas west of the building, and in soil below the floor of the building (the pit under the vapor degreaser)

5 2 Soil and Air Targets

The potential source of the contamination is an active facility Residences are located on properties adjacent to the facility The residence nearest any of the potential sources is located about 200 feet from the former west wall of

the facility (the alleged disposal area). There are 808 residences located within 0.25 mile of this location. The Modine property is fenced with a gate at the road entrance The total population within a 4-mile radius of the lagoon is 6,394 (Reference 14).

There are no wetlands of at least five acres in the vicinity of the site Smaller wetlands may be present. The Gray Bat (Myotis griesescens) is federally and state listed as endangered. The bat is known from four caves in the vicinity of Camdenton. The first cave is 2 1 miles from the site. Spinulose shield fern (Dryopteris carthusiana) is known to occur in the vicinity of the site in Red Sink Natural Area and is state listed endangered. Other sensitive environments are also present in the vicinity of the site (References 16 and 17).

5.3 Soil Exposure and Air Pathway Conclusions

The soil exposure pathway appears to pose a minimal threat at the site due to the inaccessibility of the closest potential source. Although TCE is volatile when exposed to air, a release of TCE to air is not suspected because of the length of time since releases were alleged to have occurred. In addition, many of the sites are covered with pavement, buildings, or vegetation.

6. SUMMARY AND CONCLUSIONS

The Sundstrand site is located in the City of Camdenton, Missouri, at the center of Camden County, Missouri (Figure 1). The site is located about one-half mile west of the intersections of U.S. Route 54 and Missouri Route 5/7 The suspected area of contamination includes soil beneath the Modine Heat Transfer (formerly Sundstrand) manufacturing facility, and soil and fill material comprising loading areas and parking lot adjacent to the facility on the west. The contaminants are known to include trichloroethylene (TCE) and 1,1,1-trichloroethane (TCA). Due to the relatively high conductivity of the aquifer, potential widespread migration of contaminants is high There are no residents whose private wells are within 0.25 mile of the potential source TCE and TCA are very mobile contaminants and the direction of groundwater flow is unknown There are no present indications that hazardous substances have been released into surface waters or into areas that drain toward permanently flowing surface waters. There are no water intakes located on the tributary or on Lake of the Ozarks No identified wetlands are present in the vicinity of the site. Primary targets include the fisheries of the tributary and Lake of the Ozarks, a federally designated endangered species, and other sensitive environments The soil exposure pathway appears to pose a minimal threat at the site due to the inaccessibility of the closest potential source.

REFERENCES

1 U S Geological Survey, 7 1/2 minute topographic quadrangle maps showing site location (Green Bay Terrace, Camdenton, Decaturville, Ha Ha Tonka)

2 The Climatic Atlas of the United States, U S Department of Commerce, 1983

3 Original complaint

4 Former employee's statement

5 Law Environmental, Inc report

6 CERCLIS, Camden County sites

7 MDNR hazardous waste files Hazardous Waste Registrations, Modine correspondence of 12/3/90 and 12/10/91, Sundstrand correspondence of 9/6/90

8 MDNR sampling results

9 Record of Modine/MDNR meeting

10 MDNR comment letter on sampling plan

11 Modine letter stating that it would proceed with sampling

12 Edith Starbuck, Missouri Division of Geology and Land Survey, Memorandum, 1/13/92

13 Phone call with Rick Hixson, 1/24/92

14 Census Bureau, 1990 data

15 Missouri Water Quality Standards, 10 CSR 20-7 031

16 Dan Dichkneite, Missouri Department of Conservation, letter dated 9/6/91

17 Jerry Brabender, U S Fish and Wildlife Service, letter dated 9/16/91

Sundstrand PA
January 31, 1992

TABLE 1

GROUNDWATER TARGETS

Public Water Supplies

City of Camdenton #3 (Rodeo): total depth 940 feet; cased depth 450 feet; aquifer Cambrian-Ordovician; capacity 320 gpm; distance from site 1.0 miles population served 622.

City of Camdenton #4 (Blair): total depth 1045 feet; cased depth 400 feet; aquifer Cambrian-Ordovician; capacity 300 gpm; distance from site 0 6 miles; population served 576.

City of Camdenton #6 (Mulberry): total depth 900 feet; cased depth 400 feet; aquifer Cambrian-Ordovician; capacity 575 gpm; distance from site 08 miles; population served 1105.

City of Linn Creek #1: total depth 385 feet; cased depth 170 feet; aquifer Cambrian-Ordovician; capacity 100 gpm; distance from site 2.9 miles; population served ___.

City of Linn Creek #2: total depth 860 feet; cased depth 528 feet; aquifer Cambrian-Ordovician; capacity 50 gpm; distance from site 3 1 miles; population served ___.

Camden PWSD #2: total depth 848 feet; cased depth 330 feet; aquifer Cambrian-Ordovician; capacity 100 gpm; distance from site 4 0 miles; population served ___.

Autumn Village: cased depth 260 feet; aquifer Cambrian-Ordovician; capacity 50 gpm; distance from site 1.4 miles; population served ___.

Camdenton Medical Center: total depth 1.3 feet; cased depth ___ feet; aquifer Cambrian-Ordovician; capacity ___ gpm; distance from site 1.4 miles; population served ___

Camdenton Windsor Estates: total depth 600 feet; cased depth 400 feet; aquifer Cambrian-Ordovician; capacity 140 gpm; distance from site 1 5 miles; population served ___

Cape of the Woods: total depth ___ feet; cased depth ___ feet; aquifer Cambrian-Ordovician; capacity ___ gpm; distance from site ___ miles; population served ___

Department of Conservation: elevation ___ feet; total depth ___ feet; cased depth ___ feet; aquifer Cambrian-Ordovician; capacity ___ gpm; distance from site ___ miles; population served ___.

TABLE 1

(continued)

New Tribes: total depth ___ feet; cased depth ___ feet; aquifer Cambrian-Ordovician; capacity ___ gpm; distance from site 4.0 miles; population served ___.

Oak Bluff Condominiums: total depth 545 feet; cased depth 350 feet; aquifer Cambrian-Ordovician; capacity 60 gpm; distance from site 2.7 miles; population served ___.

Southway Terrace MHC: total depth 505 feet; cased depth 350 feet; aquifer Cambrian-Ordovician; capacity ___ gpm; distance from site 2.5 miles; population served ___.

Watkins Subdivision: total depth 690 feet; cased depth 440 feet; aquifer Cambrian-Ordovician; capacity 60 gpm; distance from site 1.8 miles; population served ___.

Whispering Hills: total depth ___ feet; cased depth ___ feet; aquifer Cambrian-Ordovician; capacity ___ gpm; distance from site ___ miles; population served ___.

___ means no information obtained.

Private Water Supplies

Many motels, hotels, and restaurants along Highway 54 south of Camdenton.

All of the residences not served by the above systems

CENSUS OF MISSOURI PUBLIC WATER SYSTEMS 2018

Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Public Drinking Water Branch

Table of Contents

I. GENERAL INFORMATION

GENERAL INFORMATION
INTRODUCTION

The General Information section contains Missouri counties listed by the Department of Natural Resources' regions, and a map of the department's regional and satellite office locations.

Counties By Region

Kansas City Regional Office
Located - Kansas City
Region 1
ANDREW
ATCHISON
BATES
BENTON
BUCHANAN
CALDWELL
CASS
CLAY
CLINTON
DAVIESS
DEKALB
GENTRY
HARRISON
HENRY
HOLT
JACKSON
JOHNSON
LAFAYETTE
NODAWAY
PETTIS
PLATTE
RAY
WORTH

Northeast Regional Office
Located - Macon
Region 2
ADAIR
AUDRAIN
BOONE
CALLAWAY
CARROLL
CHARITON
CLARK
COLE
COOPER
GRUNDY
HOWARD
KNOX
LEWIS
LINN
LIVINGSTON
MACON
MARION
MERCER
MONITEAU
MONROE
OSAGE
PIKE
PUTNAM
RALLS
RANDOLPH
SALINE
SCHUYLER
SCOTLAND
SHELBY
SULLIVAN

Southeast Regional Office
Located - Poplar Bluff
Region 4
BOLLINGER
BUTLER
CAPE GIRARDEAU
CARTER
CRAWFORD
DENT
DUNKLIN
HOWELL
IRON
MADISON
MARIES
MISSISSIPPI
NEW MADRID
OREGON
PEMISCOT
PERRY
PHELPS
PULASKI
REYNOLDS
RIPLEY
SCOTT
SHANNON
ST FRANCOIS
STE GENEVIEVE
STODDARD
TEXAS
WASHINGTON
WAYNE

Southwest Regional Office
Located - Springfield
Region 5
BARRY
BARTON
CAMDEN
CEDAR
CHRISTIAN
DADE
DALLAS
DOUGLAS
GREENE
HICKORY
JASPER
LACLEDE
LAWRENCE
MCDONALD
MILLER
MORGAN
NEWTON
OZARK
POLK
ST CLAIR
STONE
TANEY
VERNON
WEBSTER
WRIGHT

St Louis Regional Office
Located - St Louis
Region 6
FRANKLIN
GASCONADE
JEFFERSON
LINCOLN
MONTGOMERY
ST CHARLES
ST LOUIS
ST LOUIS CITY
WARREN

MISSOURI DEPARTMENT OF NATURAL RESOURCES
REGIONAL OFFICES

Kansas City Area

Kansas City Regional Office
500 NE Colbern Rd.
Lee's Summit, MO 64086-4710
816-251-0700 FAX: 816-622-7044

St. Louis Area

St. Louis Regional Office
7545 S. Lindbergh, Ste 210
St. Louis, MO 63125
314-416-2960 FAX: 314-416-2970

Southeast Area

Southeast Regional Office
2155 North Westwood Blvd.
Poplar Bluff, MO 63901
573-840-9750 FAX: 573-840-9754

Missouri Geological Survey
111 Fairgrounds Rd.
Rolla, MO 65401
573-368-3625 FAX: 573-368-3912

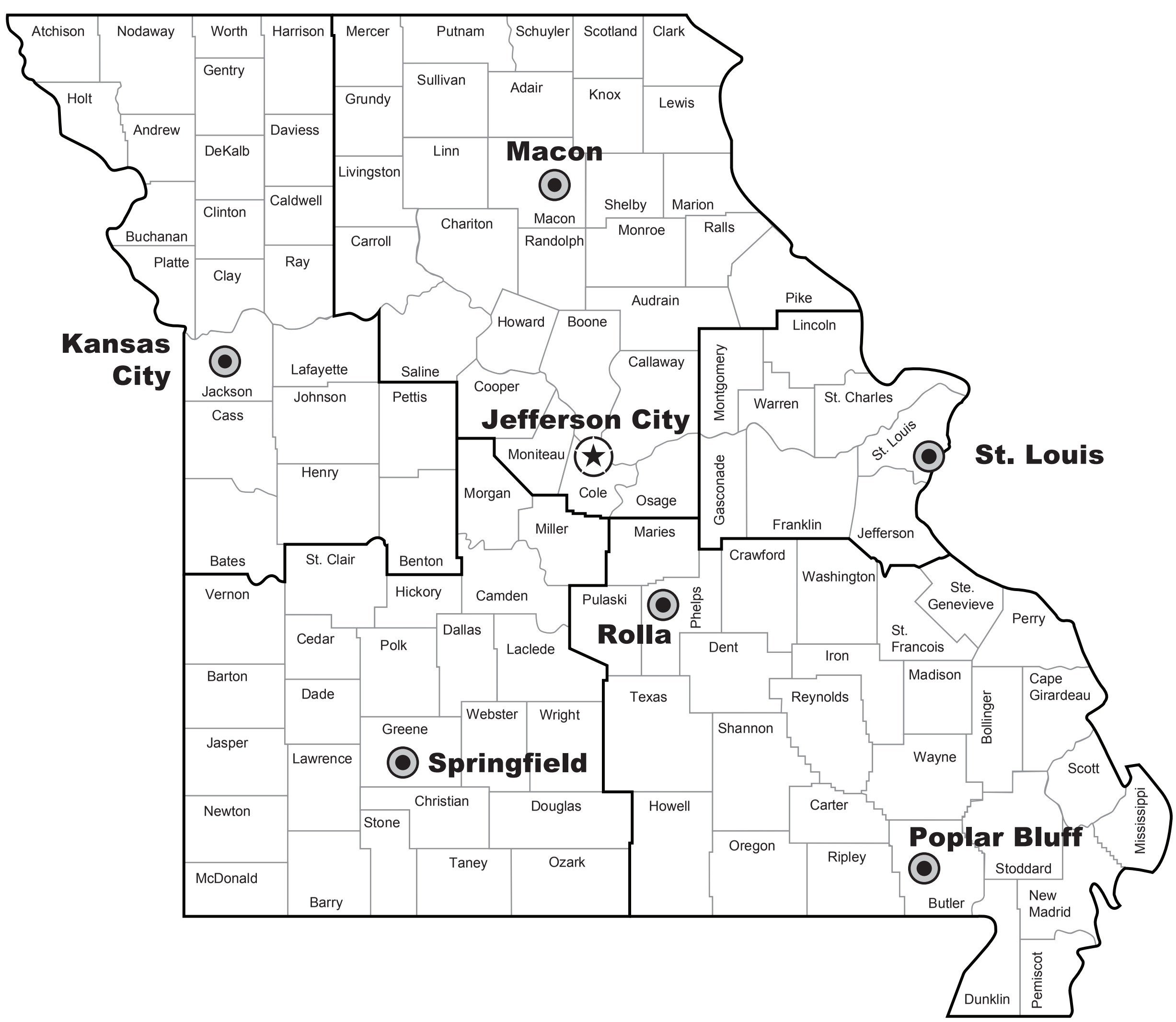
Northeast Area

Northeast Regional Office
1709 Prospect Drive
Macon, MO 63552-2602
660-385-8000 FAX: 660-385-8090

Department Central Offices
P.O. Box 176
Jefferson City, MO 65102-0176
573-751-3443
dnr.mo.gov/shared/map-jeffcity.htm

Southwest Area

Southwest Regional Office
2040 W. Woodland
Springfield, MO 65807-5912
417-891-4300 FAX: 417-891-4399



11/2017 dnr.mo.gov/regions/docs/ro-map.pdf

For more information on the department, visit dnr.mo.gov or call 800-361-4827

II. STATISTICAL INVENTORY INFORMATION

STATISTICAL INVENTORY INFORMATION
INTRODUCTION

The Statistical Inventory information section contains two tables. The first table gives the number of regulated systems by region and system type. The second table contains system totals and population totals by source type.

Number of Regulated Systems By Region and System Type

Region	Number of Community Systems	Number of Nontransient, Noncommunity Systems	Number of Transient, Noncommunity Systems	Total Number of Systems
KANSAS CITY REG OFFICE KCRO	282	12	72	366
NORTHEAST REG OFFICE NERO	194	13	8	215
SOUTHEAST REG OFFICE SERO	275	57	176	508
SOUTHWEST REG OFFICE SWRO	477	100	723	1,300
ST LOUIS REG OFFICE SLRO	197	36	110	343
Total Systems	1,425	218	1,089	2,732

Community Water System Populations

Source Type		Total Number of Systems	Total Population Served
Primary Groundwater			
	Systems using Groundwater	1,050	1,804,182
	Systems using Groundwater Under Direct Influence	3	12,425
	Total for Primary Groundwater Systems	**1,053**	**1,816,607**
Primary Surface Water			
	Systems using Surface Water - Streams	59	2,440,344
	Total for Primary Surface Water Systems	**59**	**2,440,344**
Secondary			
	Secondary System using Groundwater	154	185,124
	Secondary System using Groundwater Under Direct Influence	2	15,068
	Secondary System using Surface Water	157	907,010
	Total for Secondary Systems	**313**	**1,107,202**
	Grand Total	**1,425**	**5,364,153**

III. COMMUNITY WATER SYSTEM INVENTORY INFORMATION

COMMUNITY WATER SYSTEM INVENTORY INFORMATION
INTRODUCTION
KEY TO CODES AND ABBREVIATIONS

The Community Water System Inventory Information section contains data on community public water systems regulated by the Missouri Department of Natural Resources' Public Drinking Water Branch. A community public water system serves at least 15 service connections and is operated on a year-round basis or regularly serves at least 25 residents on a year-round basis (Missouri Safe Drinking Water Regulations 10 CSR 60-2.015). These systems include, but are not limited to, cities, water districts, subdivisions, mobile home parks and institutions.

Community water system inventory information provides basic information such as the required water system operator level and the required distribution system operator level, the year the system began providing water, the ownership type, the number of people served and the number of service connections. These systems are divided by type of community into three alphabetical lists. The first list contains city systems, the second list contains water district systems and the third list contains subdivision, mobile home park, institution and miscellaneous systems. This section also provides a list of systems that sell water and whom they sell to, as well as a list of systems that buy water and whom they buy from.

AVG = Average
MGD = Million Gallons per Day

DISTRIBUTION SYSTEM OPERATOR LEVEL (Listed second, if available under Operator Level, Example: "A1" or " 1"):
1 – Requires a minimum of one-half year of distribution operations experience. 2 – Requires a minimum of one year of distribution operations experience. 3 – Requires a minimum of three years of distribution operations experience.

Both the water system operator level and the distribution systems operator level for community public water systems are classified according to system capacity, source of water, character of water, character of water being produced, complexity of treatment and other physical conditions that may affect a system. The department uses this classification system to determine the certification level necessary for the chief operator to supervise the operation of a facility (Missouri Safe Drinking Water Regulations 10 CSR 60-14.010).

OWNER TYPE: F – Federal Government P – Private
S – State Government L – Local Government

SOURCE WATER PERCENTAGES:
PCT GRD = Percent of Source that is Groundwater
PCT PUR GRD = Percent of Source that is Purchased Groundwater
PCT PUR SUR = Percent of Source that is Purchased Surface Water
PCT SUR = Percent of Source that is Surface Water
PCT GW UNDER INFL = Percent of Source that is Groundwater under influence of Surface Water
PCT PUR GW UND INFL = Percent of Source that is Purchased Groundwater under influence of Surface Water

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
ADRIAN PWS															
System ID Number	County Location														
MO1010001	BATES	1938	B2	L	1,677	738	100	0	0	0	0	0	1.3000	1.1000	0.3260
ADVANCE PWS															
System ID Number	County Location														
MO4010002	STODDARD	1956	C2	L	1,347	646	0	100	0	0	0	0	0.5760	0.1440	0.2000
ALBA PWS															
System ID Number	County Location														
MO5010004	JASPER	1908	2	L	550	257	0	100	0	0	0	0	0.7480	0.0900	0.0550
ALBANY PWS															
System ID Number	County Location														
MO1010006	GENTRY	1951	C2	L	1,650	836	0	100	0	0	0	0	1.0000	0.2870	0.0000
ALMA PWS															
System ID Number	County Location														
MO1010009	LAFAYETTE	1954	2	L	500	222	0	0	0	100	0	0		0.0430	0.0500
ALTAMONT PWS															
System ID Number	County Location														
MO1010010	DAVIESS	1967	2	L	168	77	0	0	0	0	100	0		0.0090	0.0500
ALTENBURG PWS															
System ID Number	County Location														
MO4010011	PERRY	1959	2	L	356	172	0	100	0	0	0	0	0.0430	0.0210	0.0500
ALTON PWS															
System ID Number	County Location														
MO4010012	OREGON	1948	2	L	1,100	430	0	100	0	0	0	0	0.5110	0.1390	0.1400
AMAZONIA PWS															
System ID Number	County Location														
MO1010013	ANDREW	1958	2	L	312	125	0	0	0	0	100	0	0.0240	0.0210	0.0750
AMORET PWS															
System ID Number	County Location														
MO1010014	BATES	1965	2	L	255	102	0	0	0	100	0	0		0.0150	0.0000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
ANDERSON PWS															
System ID Number	County Location														
MO5010016	MCDONALD	1956	2	L	1,961	884	0	100	0	0	0	0	0.5260	0.5000	0.0510
ANNAPOLIS PWS															
System ID Number	County Location														
MO4010017	IRON	1965	C2	L	345	151	0	100	0	0	0	0	0.2670	0.0260	0.0500
ANNISTON PWS															
System ID Number	County Location														
MO4010018	MISSISSIPPI	1966	2	L	293	103	0	0	0	0	100	0	0.1440	0.0120	0.0500
APPLETON CITY PWS															
System ID Number	County Location														
MO5010020	ST CLAIR	1956	2	L	1,518	525	0	0	0	100	0	0		0.1000	0.1000
ARBYRD PWS															
System ID Number	County Location														
MO4010022	DUNKLIN	1962	2	L	509	218	0	100	0	0	0	0	0.4320	0.0410	0.0550
ARCADIA PWS															
System ID Number	County Location														
MO4010023	IRON	1938	2	L	603	258	0	100	0	0	0	0	0.1700	0.0540	0.2220
ARCHIE PWS															
System ID Number	County Location														
MO1010024	CASS	1957	B2	L	1,170	536	100	0	0	0	0	0	0.3600	0.0070	38.2550
ARCOLA PWS															
System ID Number	County Location														
MO5010025	DADE	1966	1	L	45	47	0	100	0	0	0	0	0.2880	0.0040	0.0100
ARROW POINT VILLAGE PWS															
System ID Number	County Location														
MO5010027	BARRY	1990	2	L	120	66	0	100	0	0	0	0	0.0820	0.0100	0.0110
ARROW ROCK PWS															
System ID Number	County Location														
MO2010029	SALINE	1968	1	L	54	94	0	0	0	0	100	0		0.0100	0.0300

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
ASBURY PWS															
System ID Number	County Location														
MO5010031	JASPER	1954	1	L	207	98	0	100	0	0	0	0	0.1800	0.0120	0.0030
ASH GROVE PWS															
System ID Number	County Location														
MO5010032	GREENE	1954	2	L	1,472	668	0	100	0	0	0	0	1.3390	2.0000	0.2000
ASHLAND PWS															
System ID Number	County Location														
MO3010033	BOONE	1992	2	L	3,707	1,701	0	100	0	0	0	0	1.5330	0.2620	0.8000
ATLANTA PWS															
System ID Number	County Location														
MO2010035	MACON	1967	2	L	385	175	0	0	0	100	0	0	0.0720	0.0200	0.0500
AURORA VERONA															
System ID Number	County Location														
MO5010038	LAWRENCE	1889	2	P	8,529	3,659	0	100	0	0	0	0	2.0400	1.0930	0.8000
AUXVASSE PWS															
System ID Number	County Location														
MO3010039	CALLAWAY	1913	2	L	983	429	0	100	0	0	0	0	3.4500	0.0540	0.2000
AVA PWS															
System ID Number	County Location														
MO5010040	DOUGLAS	1930	2	L	3,082	1,395	0	100	0	0	0	0	1.5330	0.6200	1.0750
BAKERSFIELD PWS															
System ID Number	County Location														
MO5011066	OZARK	1984	2	L	234	134	0	100	0	0	0	0	0.1300	0.0360	0.0850
BARNARD PWS															
System ID Number	County Location														
MO1010046	NODAWAY	1963	2	L	248	111	0	0	0	0	100	0	0.0570	0.0170	0.1040
BARNETT PWS															
System ID Number	County Location														
MO3010047	MORGAN	1964	2	L	215	104	0	100	0	0	0	0	0.1000	0.0100	0.0500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
BATES CITY PWS															
System ID Number	County Location														
MO1010049	LAFAYETTE	1964	1	L	288	115	0	0	0	0	100	0	0.0500	0.8210	0.2000
BELL CITY PWS															
System ID Number	County Location														
MO4010052	STODDARD	1962	2	L	441	205	0	100	0	0	0	0	0.0580	0.0350	0.0580
BELLE PWS															
System ID Number	County Location														
MO3010054	MARIES	1937	2	L	1,545	722	0	100	0	0	0	0	0.6500	0.1450	0.4000
BELLFLOWER PWS															
System ID Number	County Location														
MO6010058	MONTGOMERY	1964	2	L	413	207	0	100	0	0	0	0	0.3100	0.0350	0.1400
BELTON PWS															
System ID Number	County Location														
MO1010061	CASS	1930	3	L	23,175	8,131	0	0	0	100	0	0		1.7030	6.8000
BENTON PWS															
System ID Number	County Location														
MO4010062	SCOTT	1903	2	L	1,097	383	0	100	0	0	0	0	0.1200	0.0700	0.1250
BERGER PWS															
System ID Number	County Location														
MO6010064	FRANKLIN	1957	2	L	200	97	0	100	0	0	0	0	0.0270	0.0210	0.0400
BERNIE PWS															
System ID Number	County Location														
MO4010066	STODDARD	1940	C2	L	1,928	1,005	0	100	0	0	0	0	3.4560	0.3500	0.3200
BERTRAND PWS															
System ID Number	County Location														
MO4010067	MISSISSIPPI	1966	C2	L	821	305	0	100	0	0	0	0	0.1440	0.0560	0.0500
BETHANY PWS															
System ID Number	County Location														
MO1010068	HARRISON	1937	B2	L	3,292	1,594	100	0	0	0	0	0	0.0000	0.3150	0.1270

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
BEVIER PWS															
System ID Number	County Location														
MO2010881	MACON	1959	2	L	762	350	0	0	0	100	0	0		0.0550	0.0550
BIG LAKE VILLAGE OF PWS															
System ID Number	County Location														
MO1011182	HOLT	1997	2	L	800	246	0	0	0	0	100	0		0.0280	0.1500
BILLINGS PWS															
System ID Number	County Location														
MO5010071	CHRISTIAN	1942	2	L	1,035	469	0	100	0	0	0	0	0.4750	0.1000	0.2000
BIRCH TREE PWS															
System ID Number	County Location														
MO4010072	SHANNON	1943	2	L	775	293	0	100	0	0	0	0	0.5250	0.0940	0.1000
BIRMINGHAM VILLAGE OF PWS															
System ID Number	County Location														
MO1010070	CLAY	1977	2	L	190	81	0	0	0	80	20	0		0.0150	0.0000
BISMARCK PWS															
System ID Number	County Location														
MO4010073	ST FRANCOIS	1940	2	L	1,450	654	0	100	0	0	0	0	0.4820	0.1160	0.3000
BLACKWATER PWS															
System ID Number	County Location														
MO3010075	COOPER	1955	2	L	205	98	0	0	0	0	100	0	0.1000	0.0110	0.0650
BLAIRSTOWN PWS															
System ID Number	County Location														
MO1010076	HENRY	1960	2	L	185	49	0	17	0	83	0	0		0.0060	0.0210
BLAND PWS															
System ID Number	County Location														
MO6010077	GASCONADE	1936	D2	L	539	247	0	100	0	0	0	0	0.4320	0.0500	0.1000
BLODGETT PWS															
System ID Number	County Location														
MO4011179	SCOTT	1999	C1	L	213	125	0	100	0	0	0	0	0.1080	0.0180	0.0580

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
BLOOMFIELD PWS															
System ID Number	County Location														
MO4010078	STODDARD	1930	C2	L	1,933	812	0	100	0	0	0	0	0.4000	0.2090	0.3000
BLOOMSDALE PWS															
System ID Number	County Location														
MO4010079	STE GENEVIEVE	1965	2	L	521	229	0	100	0	0	0	0		0.0440	0.0790
BLUE SPRINGS PWS															
System ID Number	County Location														
MO1010080	JACKSON	1936	3	L	52,530	20,921	0	0	0	21	79	0		5.5460	8.0000
BOGARD PWS															
System ID Number	County Location														
MO2010082	CARROLL	1962	1	L	260	94	0	0	0	0	100	0		0.0070	0.0000
BOLCKOW PWS															
System ID Number	County Location														
MO1010084	ANDREW	1966	C2	L	187	77	0	100	0	0	0	0	0.1440	0.0490	0.0800
BOLIVAR PWS															
System ID Number	County Location														
MO5010085	POLK	1900	2	L	10,572	4,207	0	100	0	0	0	0	4.4560	1.1120	1.4500
BONNE TERRE PWS															
System ID Number	County Location														
MO4010087	ST FRANCOIS	1927	2	L	4,000	1,609	0	100	0	0	0	0	0.9360	0.4000	0.7000
BOONVILLE PWS															
System ID Number	County Location														
MO3010089	COOPER	1880	A3	L	8,319	3,122	100	0	0	0	0	0	4.6080	1.1250	3.2760
BOSWORTH PWS															
System ID Number	County Location														
MO2010091	CARROLL	1951	C2	L	305	114	0	100	0	0	0	0	0.0860	0.0170	0.0500
BOURBON PWS															
System ID Number	County Location														
MO6010092	CRAWFORD	1952	2	L	1,640	754	0	100	0	0	0	0	1.0000	0.1270	0.3750

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
BOWLING GREEN PWS															
System ID Number	County Location														
MO2010093	PIKE	1927	A3	L	5,334	1,449	87	0	0	13	0	0	2.4600	0.3000	2.6200
BRANSON PWS															
System ID Number	County Location														
MO5010096	TANEY	1939	A3	L	11,880	4,088	80	20	0	0	0	0	11.4000	3.7400	4.4020
BRANSON WEST PWS															
System ID Number	County Location														
MO5010158	STONE	1993	2	L	478	279	0	100	0	0	0	0	1.1370	0.1640	0.6000
BRASHEAR PWS															
System ID Number	County Location														
MO2010097	ADAIR	1960	2	L	288	121	0	0	0	100	0	0		0.0180	0.0600
BRAYMER PWS															
System ID Number	County Location														
MO1010098	CALDWELL	1951	C2	L	878	388	0	100	0	0	0	0	0.1440	0.0520	0.2500
BRECKENRIDGE PWS															
System ID Number	County Location														
MO1010099	CALDWELL	1958	2	L	333	129	0	0	0	0	100	0	0.1440	0.0500	0.1000
BRONAUGH PWS															
System ID Number	County Location														
MO5010104	VERNON	1959	D1	L	245	89	0	100	0	0	0	0	0.0720	0.0140	0.0500
BROOKFIELD PWS															
System ID Number	County Location														
MO2010105	LINN	1891	A2	L	4,542	2,019	100	0	0	0	0	0	1.2500	0.4940	91.7500
BROWNING PWS															
System ID Number	County Location														
MO2010108	LINN	1956	2	L	265	117	0	0	0	100	0	0	0.0500	0.0170	0.0500
BUCKLIN PWS															
System ID Number	County Location														
MO2010112	LINN	1938	2	L	467	226	0	0	0	100	0	0		0.0000	0.1000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
BUCKNER PWS															
System ID Number	County Location														
MO1010113	JACKSON	1957	2	L	3,076	1,062	0	0	0	0	100	0		0.2330	0.2500
BUFFALO PWS															
System ID Number	County Location														
MO5010114	DALLAS	1925	D2	L	3,100	1,438	0	100	0	0	0	0	3.3070	0.3540	0.6750
BUNCETON PWS															
System ID Number	County Location														
MO3010115	COOPER	1954	2	L	354	167	0	100	0	0	0	0	0.3160	0.0260	0.0500
BUNKER PWS															
System ID Number	County Location														
MO4010883	DENT	1963	2	L	407	187	0	100	0	0	0	0	0.1730	0.0420	0.0500
BURLINGTON JUNCTION PWS															
System ID Number	County Location														
MO1010117	NODAWAY	1924	C2	L	587	237	0	100	0	0	0	0	0.1440	0.0450	0.0500
BUTLER PWS															
System ID Number	County Location														
MO1010118	BATES	1915	A2	L	4,219	2,157	100	0	0	0	0	0	1.0760	0.6790	1.4000
BUTTERFIELD PWS															
System ID Number	County Location														
MO5010119	BARRY	1992	2	L	470	153	0	100	0	0	0	0	0.1500	0.0210	0.0670
CABOOL PWS															
System ID Number	County Location														
MO4010120	TEXAS	1926	D2	L	2,132	875	0	100	0	0	0	0	1.3890	0.2530	0.7100
CAINSVILLE PWS															
System ID Number	County Location														
MO1010122	HARRISON	1971	2	L	296	150	0	0	0	0	100	0	0.0240	0.0180	0.0750
CALEDONIA PWS															
System ID Number	County Location														
MO4010003	WASHINGTON	1991	1	L	130	62	0	100	0	0	0	0	0.0500	0.0050	0.0250

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CALHOUN PWS															
System ID Number	County Location														
MO1010123	HENRY	1961	2	L	496	163	0	0	0	100	0	0	0.0930	0.0240	0.0930
CALIFORNIA PWS															
System ID Number	County Location														
MO3010124	MONITEAU	1992	D2	L	4,278	2,026	0	100	0	0	0	0	4.1200	1.1210	1.7500
CALLAO PWS															
System ID Number	County Location														
MO2010125	MACON	1960	2	L	311	129	0	0	0	100	0	0	0.0430	0.0240	0.0500
CAMDENTON PWS															
System ID Number	County Location														
MO3010130	CAMDEN	1931	2	L	3,718	1,729	0	100	0	0	0	0	1.2000	0.5000	0.5000
CAMERON PWS															
System ID Number	County Location														
MO1010131	CLINTON	1919	A3	L	9,933	2,954	100	0	0	0	0	0	2.8800	1.3190	2.4000
CAMPBELL PWS															
System ID Number	County Location														
MO4010132	DUNKLIN	1911	2	L	2,240	867	0	100	0	0	0	0	1.1520	0.2080	0.3500
CANTON PWS															
System ID Number	County Location														
MO2010134	LEWIS	1937	B2	L	2,377	914	0	100	0	0	0	0	0.5760	0.2750	0.6130
CAPE GIRARDEAU PWS															
System ID Number	County Location														
MO4010136	CAPE GIRARDEAU	1931	A3	L	39,628	18,838	0	100	0	0	0	0	10.3800	5.0500	9.2350
CARDWELL PWS															
System ID Number	County Location														
MO4010137	DUNKLIN	1951	2	L	713	278	0	100	0	0	0	0	0.4320	0.0380	0.0750
CARL JUNCTION PWS															
System ID Number	County Location														
MO5010138	JASPER	1910	D2	L	7,445	2,930	0	100	0	0	0	0	4.6150	0.2380	0.9500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CARROLLTON PWS															
System ID Number	County Location														
MO2010140	CARROLL	1941	A2	L	3,300	1,812	0	100	0	0	0	0	2.4000	0.6000	2.3400
CARTERVILLE PWS															
System ID Number	County Location														
MO5010141	JASPER	1910	2	L	1,972	776	0	100	0	0	0	0		0.3000	0.3000
CARTHAGE PWS															
System ID Number	County Location														
MO5010142	JASPER	1909	C3	L	14,570	5,530	0	100	0	0	0	0	5.0000	2.7530	7.6000
CARUTHERSVILLE PWS															
System ID Number	County Location														
MO4010143	PEMISCOT	1902	C2	L	6,100	2,028	0	100	0	0	0	0	2.8000	0.8250	1.9750
CASSVILLE PWS															
System ID Number	County Location														
MO5010144	BARRY	1931	2	L	3,133	1,604	0	100	0	0	0	0	3.3760	0.4250	1.3500
CENTERTOWN PWS															
System ID Number	County Location														
MO3010149	COLE	1961	2	L	278	278	0	100	0	0	0	0	0.2590	0.0190	0.0500
CENTERVIEW PWS															
System ID Number	County Location														
MO1010150	JOHNSON	1963	2	L	267	107	0	0	0	0	100	0	0.0180	0.0160	0.0750
CENTERVILLE PWS															
System ID Number	County Location														
MO4010151	REYNOLDS	1968	2	L	200	100	0	100	0	0	0	0	0.1870	0.0150	0.0330
CENTRALIA PWS															
System ID Number	County Location														
MO3010152	BOONE	1910	C2	L	4,027	1,909	0	100	0	0	0	0	1.4440	0.6500	1.0600
CHAFFEE PWS															
System ID Number	County Location														
MO4010154	SCOTT	1917	C2	L	2,950	1,163	0	100	0	0	0	0	0.5760	0.1600	0.4800

City Water Systems

Community Water System Name System ID Number	County Location	Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CHAIN O LAKES VILLAGE PWS															
MO5010968	BARRY	1975	2	L	160	83	0	100	0	0	0	0	0.2880	0.0180	0.0160
CHAMOIS PWS															
MO3010155	OSAGE	1923	2	L	395	244	0	100	0	0	0	0	0.3160	0.0400	0.1500
CHARLESTON PWS															
MO4010160	MISSISSIPPI	1927	C2	L	5,200	1,556	0	100	0	0	0	0	2.0700	1.2710	1.7000
CHILHOWEE PWS															
MO1010161	JOHNSON	1956	2	L	335	138	0	0	0	0	100	0	0.0250	0.0200	0.0500
CHILLICOTHE MUNICIPAL UTILITIES															
MO2010162	LIVINGSTON	1877	A2	L	9,515	3,865	0	100	0	0	0	0	4.5000	1.3000	2.0000
CHULA PWS															
MO2010163	LIVINGSTON	1959	1	L	210	98	0	0	0	0	100	0	0.0330	0.0120	0.0500
CLARENCE PWS															
MO2010165	SHELBY	1935	2	L	813	357	0	0	0	100	0	0		0.0800	0.0700
CLARK PWS															
MO2010882	RANDOLPH	1962	2	L	300	122	0	0	0	0	100	0	0.1200	0.0160	0.0500
CLARKSBURG PWS															
MO3010166	MONITEAU	1957	2	L	334	4	0	100	0	0	0	0	0.3310	0.0180	0.0600
CLARKSDALE PWS															
MO1010167	DEKALB	1963	2	L	271	119	0	0	0	0	100	0	0.0180	0.0130	0.0500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CLARKSVILLE PWS															
System ID Number	County Location														
MO2010169	PIKE	1921	C2	L	442	258	0	100	0	0	0	0	0.1440	0.0540	0.3030
CLARKTON PWS															
System ID Number	County Location														
MO4010170	DUNKLIN	1939	D2	L	1,200	487	0	100	0	0	0	0	0.8490	0.0960	0.2000
CLEARMONT PWS															
System ID Number	County Location														
MO1010173	NODAWAY	1965	2	L	171	86	0	0	0	100	0	0	0.0500	0.0090	0.0500
CLEVELAND PWS															
System ID Number	County Location														
MO1010174	CASS	1961	2	L	661	266	0	0	0	100	0	0	0.0500	0.0350	0.0840
CLEVER PWS															
System ID Number	County Location														
MO5010175	CHRISTIAN	1948	2	L	2,139	1,071	0	100	0	0	0	0	1.1560	0.1800	0.3500
COFFEY PWS															
System ID Number	County Location														
MO1010179	DAVIESS	1966	2	L	251	73	0	0	0	0	100	0	0.0860	0.0080	0.0000
COLE CAMP PWS															
System ID Number	County Location														
MO3010180	BENTON	1912	2	L	1,120	525	0	100	0	0	0	0	0.7500	0.1000	0.2500
COLLINS PWS															
System ID Number	County Location														
MO5010884	ST CLAIR	1966	1	L	156	79	0	100	0	0	0	0	0.1360	0.0100	0.0170
COLUMBIA PWS															
System ID Number	County Location														
MO3010181	BOONE	1904	A3	L	100,733	48,726	0	90	0	0	10	0	32.0000	12.0000	15.4350
CONCEPTION JUNCTION PWS															
System ID Number	County Location														
MO1010182	NODAWAY	1958	C2	L	204	78	0	100	0	0	0	0	0.0200	0.0130	0.0300

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CONCORDIA PWS															
System ID Number	County Location														
MO1010184	LAFAYETTE	1910	A2	L	2,450	1,030	100	0	0	0	0	0	2.0160	0.6000	1.1400
CONWAY PWS															
System ID Number	County Location														
MO5010185	LACLEDE	1949	2	L	788	332	0	100	0	0	0	0	0.6120	0.1500	0.1000
COOTER PWS															
System ID Number	County Location														
MO4010885	PEMISCOT	1965	2	L	449	200	0	0	0	0	100	0	0.0720	0.0350	0.0500
CORDER PWS															
System ID Number	County Location														
MO1010187	LAFAYETTE	1954	2	L	439	210	0	0	0	100	0	0		0.0740	0.0000
CRAIG PWS															
System ID Number	County Location														
MO1010191	HOLT	1939	C2	L	335	136	0	100	0	0	0	0	0.1700	0.1320	0.1650
CRANE PWS															
System ID Number	County Location														
MO5010192	STONE	1926	D2	L	1,492	655	0	100	0	0	0	0	1.0370	0.7000	0.6000
CREIGHTON PWS															
System ID Number	County Location														
MO1010193	CASS	1958	2	L	350	145	0	0	0	0	100	0	0.0350	0.0280	0.0370
CROCKER PWS															
System ID Number	County Location														
MO3010196	PULASKI	1940	2	L	1,011	434	0	100	0	0	0	0	0.6400	0.0590	0.2000
CROSS TIMBERS PWS															
System ID Number	County Location														
MO5010197	HICKORY	1966	1	L	215	80	0	100	0	0	0	0	0.1800	0.0130	0.0500
CRYSTAL CITY PWS															
System ID Number	County Location														
MO6010198	JEFFERSON	1927	A3	L	4,900	2,014	80	0	20	0	0	0	0.9000	0.4840	1.7500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CUBA PWS															
System ID Number	County Location														
MO6010200	CRAWFORD	1931	D2	L	3,250	1,568	0	100	0	0	0	0	1.7500	0.7970	0.9750
CURRYVILLE PWS															
System ID Number	County Location														
MO2010201	PIKE	1957	2	L	255	28	0	0	0	100	0	0		0.0110	0.0000
DADEVILLE PWS															
System ID Number	County Location														
MO5010202	DADE	1965	2	L	248	212	0	100	0	0	0	0	0.2160	0.0230	0.1100
DEARBORN PWS															
System ID Number	County Location														
MO1010204	PLATTE	1958	2	L	575	250	0	0	0	80	20	0	0.2150	0.0520	0.2150
DEEPWATER PWS															
System ID Number	County Location														
MO1010205	HENRY	1936	2	L	433	179	0	0	0	100	0	0		0.0360	0.0500
DEKALB PWS															
System ID Number	County Location														
MO1011181	BUCHANAN	1996	2	L	250	98	0	0	0	0	100	0	0.0500	0.0190	0.0500
DELTA PWS															
System ID Number	County Location														
MO4010211	CAPE GIRARDEAU	1968	2	L	636	190	0	100	0	0	0	0	0.1580	0.0240	0.0500
DESLOGE PWS															
System ID Number	County Location														
MO4011441	ST FRANCOIS	2008	2	L	5,150	1,901	0	100	0	0	0	0		0.3690	0.9000
DESOTO PWS															
System ID Number	County Location														
MO6010213	JEFFERSON	1925	2	L	6,400	2,605	0	100	0	0	0	0	1.5000	0.6500	1.0000
DEWITT PWS															
System ID Number	County Location														
MO2010215	CARROLL	1967	1	L	125	58	0	0	0	0	100	0		0.0080	0.0000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
DEXTER PWS															
System ID Number	County Location														
MO4010216	STODDARD	1913	B2	L	8,000	3,734	0	100	0	0	0	0	4.0000	2.0000	2.3500
DIAMOND PWS															
System ID Number	County Location														
MO5010217	NEWTON	1959	2	L	926	474	0	100	0	0	0	0	0.5400	0.1150	0.3000
DIGGINS PWS															
System ID Number	County Location														
MO5010218	WEBSTER	1965	2	L	300	142	0	100	0	0	0	0	0.4000	0.0270	0.1480
DIXON PWS															
System ID Number	County Location														
MO3010219	PULASKI	1939	2	L	1,500	645	0	100	0	0	0	0	0.5600	0.1460	0.2750
DONIPHAN PWS															
System ID Number	County Location														
MO4010221	RIPLEY	1898	2	L	2,000	906	0	100	0	0	0	0	1.6560	0.1720	0.4500
DOWNING PWS															
System ID Number	County Location														
MO2010224	SCHUYLER	1969	2	L	335	198	0	0	0	100	0	0	0.0720	0.0250	0.0250
DREXEL PWS															
System ID Number	County Location														
MO1010225	CASS	1954	2	L	1,200	434	0	0	0	0	100	0	0.1250	0.0480	0.2880
DUDLEY PWS															
System ID Number	County Location														
MO4010226	STODDARD	1968	C2	L	230	97	0	100	0	0	0	0	0.0600	0.0250	0.1500
DUENWEG PWS															
System ID Number	County Location														
MO5010227	JASPER	1958	2	L	1,200	683	0	100	0	0	0	0	1.0360	0.1600	0.1550
EAST LYNNE PWS															
System ID Number	County Location														
MO1010233	CASS	1966	2	L	303	153	0	0	0	0	100	0	0.0500	0.0300	0.0500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
EAST PRAIRIE PWS															
System ID Number	County Location														
MO4010235	MISSISSIPPI	1937	C2	L	3,176	1,305	0	100	0	0	0	0	0.4930	0.3650	0.0000
EASTON PWS															
System ID Number	County Location														
MO1010234	BUCHANAN	1965	2	L	234	104	0	0	0	0	100	0		0.0120	0.0500
EDGERTON PWS															
System ID Number	County Location														
MO1010237	PLATTE	1955	2	L	600	281	0	0	0	100	0	0	0.0860	0.0460	0.1080
EDINA PWS															
System ID Number	County Location														
MO2010238	KNOX	1992	2	L	1,153	605	0	0	0	100	0	0	0.5040	0.0700	0.3000
EL DORADO SPRINGS PWS															
System ID Number	County Location														
MO5010241	CEDAR	1903	3	L	3,593	1,710	0	100	0	0	0	0	2.3470	0.4790	0.5000
ELDON PWS															
System ID Number	County Location														
MO3010240	MILLER	1921	2	L	4,895	2,336	0	100	0	0	0	0	1.8000	0.5250	1.0000
ELLINGTON PWS															
System ID Number	County Location														
MO4010243	REYNOLDS	1940	2	L	987	395	0	100	0	0	0	0	0.3600	0.1170	0.2650
ELLSINORE PWS															
System ID Number	County Location														
MO4010246	CARTER	1950	2	L	600	272	0	100	0	0	0	0	0.5760	0.0680	0.1000
ELMER PWS															
System ID Number	County Location														
MO2010247	MACON	1962	2	L	115	44	0	0	0	100	0	0	0.0500	0.0050	0.0320
ELMO PWS															
System ID Number	County Location														
MO1010249	NODAWAY	1965	2	L	165	70	0	0	0	100	0	0	0.0240	0.0130	0.0500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
ELSBERRY PWS															
System ID Number	County Location														
MO6010250	LINCOLN	1935	C2	L	1,963	845	0	100	0	0	0	0	0.5040	0.1300	0.6400
EMERALD BEACH VILLAGE OF PWS															
System ID Number	County Location														
MO5010999	BARRY	1971	2	L	484	231	0	100	0	0	0	0	0.1440	0.0370	0.0720
EMINENCE PWS															
System ID Number	County Location														
MO4010253	SHANNON	1955	2	L	605	349	0	100	0	0	0	0	0.4320	0.2520	0.2610
EMMA PWS															
System ID Number	County Location														
MO1010254	LAFAYETTE	1968	2	L	205	155	0	0	0	100	0	0		0.3160	0.0500
ESSEX PWS															
System ID Number	County Location														
MO4010255	STODDARD	1957	D2	L	474	260	0	100	0	0	0	0	0.3240	0.0470	0.0690
EUGENE PWS															
System ID Number	County Location														
MO3010257	COLE	1962	1	L	220	45	0	100	0	0	0	0	0.2520	0.0210	0.0250
EUREKA PWS															
System ID Number	County Location														
MO6010258	ST LOUIS	1959	C3	L	10,000	3,776	0	100	0	0	0	0	1.6560	0.6450	2.7500
EVERTON PWS															
System ID Number	County Location														
MO5010259	DADE	1964	2	L	352	140	0	100	0	0	0	0	0.1450	0.0170	0.0500
EXCELSIOR SPRINGS PWS															
System ID Number	County Location														
MO1010261	CLAY	1906	B3	L	11,084	4,400	0	100	0	0	0	0	5.0000	2.0000	7.1000
EXETER PWS															
System ID Number	County Location														
MO5010262	BARRY	1959	2	L	772	306	0	100	0	0	0	0	0.5760	0.0520	0.2500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
FAIR PLAY PWS															
System ID Number	County Location														
MO5010264	POLK	1939	2	L	475	196	0	100	0	0	0	0	0.3000	0.0320	0.0500
FAIRFAX PWS															
System ID Number	County Location														
MO1010265	ATCHISON	1934	C2	L	637	320	0	0	0	0	100	0	0.3080	0.0400	0.1000
FAIRVIEW PWS															
System ID Number	County Location														
MO5010267	NEWTON	1967	2	L	380	165	0	100	0	0	0	0	0.2160	0.0300	0.0500
FARBER PWS															
System ID Number	County Location														
MO2010268	AUDRAIN	1957	2	L	450	156	0	0	0	100	0	0	0.1440	0.0180	0.1500
FARMINGTON PWS															
System ID Number	County Location														
MO4010270	ST FRANCOIS	1903	C3	L	19,351	5,873	0	100	0	0	0	0	2.3500	1.9500	3.9000
FAYETTE PWS															
System ID Number	County Location														
MO2010271	HOWARD	1906	2	L	2,800	1,040	0	0	0	0	100	0	1.1520	0.3610	0.5270
FERRELVIEW PWS															
System ID Number	County Location														
MO1010481	PLATTE	1993	2	L	455	133	0	0	0	100	0	0		0.0270	0.0000
FESTUS PWS															
System ID Number	County Location														
MO6010276	JEFFERSON	1924	2	L	11,600	5,047	0	0	0	0	0	100	0.8990	0.8500	2.0680
FILLMORE PWS															
System ID Number	County Location														
MO1010277	ANDREW	1964	2	L	250	86	0	0	0	0	100	0	0.0120	0.0100	0.0500
FISK PWS															
System ID Number	County Location														
MO4010278	BUTLER	1964	C2	L	329	182	0	100	0	0	0	0			0.1000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
FLEMINGTON PWS															
System ID Number	County Location														
MO5010903	POLK	1964	2	L	53	25	0	100	0	0	0	0	0.3450	0.0060	0.0100
FORDLAND PWS															
System ID Number	County Location														
MO5010283	WEBSTER	1960	1	L	800	321	0	100	0	0	0	0	0.5040	0.0710	0.1000
FORSYTH PWS															
System ID Number	County Location														
MO5010285	TANEY	1937	D2	L	2,255	1,124	0	100	0	0	0	0	2.2180	0.2390	0.6390
FRANKENSTEIN PWS															
System ID Number	County Location														
MO3010904	OSAGE	1976	1	L	125	48	0	100	0	0	0	0	0.0530	0.0070	0.0000
FRANKFORD PWS															
System ID Number	County Location														
MO2010288	PIKE	1989	1	L	323	147	0	0	0	100	0	0		0.0240	0.0540
FREDERICKTOWN PWS															
System ID Number	County Location														
MO4010290	MADISON	1925	A2	L	4,000	2,179	100	0	0	0	0	0	2.0000	0.4500	1.1320
FREEBURG PWS															
System ID Number	County Location														
MO3010291	OSAGE	1965	2	L	437	264	0	100	0	0	0	0	0.5900	0.7600	0.1500
FREEMAN PWS															
System ID Number	County Location														
MO1010292	CASS	1960	2	L	482	211	0	0	0	100	0	0	0.0470	0.0300	0.0470
FREISTATT PWS															
System ID Number	County Location														
MO5010941	LAWRENCE	1972	2	L	165	83	0	100	0	0	0	0	0.0860	0.0120	0.0930
FROHNA PWS															
System ID Number	County Location														
MO4010293	PERRY	1961	2	L	350	153	0	100	0	0	0	0	0.0930	0.0250	0.5000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
FULTON PWS															
System ID Number	County Location														
MO3010296	CALLAWAY	1937	3	L	12,128	4,261	0	100	0	0	0	0	4.3900	1.7000	4.3130
GAINESVILLE PWS															
System ID Number	County Location														
MO5010297	OZARK	1951	2	L	773	398	0	100	0	0	0	0	1.0440	0.1630	0.2500
GALENA PWS															
System ID Number	County Location														
MO5010298	STONE	1936	2	L	414	205	0	100	0	0	0	0	0.8640	0.0420	1.0490
GALLATIN PWS															
System ID Number	County Location														
MO1010299	DAVIESS	1898	C2	L	1,785	801	0	100	0	0	0	0	0.7200	0.2870	0.5500
GALT PWS															
System ID Number	County Location														
MO2010300	GRUNDY	1963	2	L	253	108	0	0	0	100	0	0		0.0200	0.1000
GARDEN CITY PWS															
System ID Number	County Location														
MO1010301	CASS	1957	B2	L	1,642	642	100	0	0	0	0	0		0.1000	0.6250
GASCONADE PWS															
System ID Number	County Location														
MO6010302	GASCONADE	1937	2	L	280	106	0	100	0	0	0	0	0.2900	0.0090	0.0840
GERALD PWS															
System ID Number	County Location														
MO6010303	FRANKLIN	1937	2	L	1,345	586	0	100	0	0	0	0	1.4190	0.1120	0.2500
GIDEON PWS															
System ID Number	County Location														
MO4010304	NEW MADRID	1932	2	L	1,051	475	0	100	0	0	0	0	0.9360	0.9360	0.1500
GILLIAM PWS															
System ID Number	County Location														
MO2010305	SALINE	1958	2	L	125	106	0	0	0	0	100	0		0.0180	0.0500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
GILMAN CITY PWS															
System ID Number	County Location														
MO1010306	HARRISON	1968	2	L	460	197	0	0	0	0	100	0		0.0210	0.0500
GLADSTONE PWS															
System ID Number	County Location														
MO1010307	CLAY	1960	A3	L	27,000	9,366	0	100	0	0	0	0	8.0000	2.4000	7.0000
GLASGOW PWS															
System ID Number	County Location														
MO2010308	HOWARD	1940	B2	L	1,103	526	0	100	0	0	0	0	0.7500	0.1670	0.6000
GLENWOOD PWS															
System ID Number	County Location														
MO2010312	SCHUYLER	1968	1	L	195	87	0	0	0	100	0	0		0.0130	0.0300
GOLDEN CITY PWS															
System ID Number	County Location														
MO5010313	BARTON	1937	2	L	764	333	0	100	0	0	0	0	0.5760	0.0700	0.1050
GOODMAN PWS															
System ID Number	County Location														
MO5010315	MCDONALD	1942	2	L	1,250	461	0	100	0	0	0	0	0.5760	0.1660	0.1500
GOWER PWS															
System ID Number	County Location														
MO1010318	CLINTON	1954	2	L	1,526	590	0	0	0	0	100	0		0.1060	0.2250
GRAHAM PWS															
System ID Number	County Location														
MO1010319	NODAWAY	1964	D2	L	170	71	0	100	0	0	0	0	0.0180	0.0150	0.0550
GRAIN VALLEY PWS															
System ID Number	County Location														
MO1010320	JACKSON	1962	3	L	13,000	5,479	0	0	0	0	100	0		0.6920	1.7740
GRANBY PWS															
System ID Number	County Location														
MO5010321	NEWTON	1912	2	L	2,100	776	0	100	0	0	0	0	0.7920	0.2390	0.1750

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
GRANDIN PWS															
System ID Number	County Location														
MO4010322	CARTER	1965	2	L	243	102	0	100	0	0	0	0	0.1610	0.0170	0.0750
GRANT CITY PWS															
System ID Number	County Location														
MO1010324	WORTH	1930	1	L	826	415	0	0	0	100	0	0		0.1420	0.2700
GREEN CASTLE PWS															
System ID Number	County Location														
MO2010328	SULLIVAN	1972	1	L	275	130	0	0	0	100	0	0		0.0330	0.0500
GREEN CITY PWS															
System ID Number	County Location														
MO2010329	SULLIVAN	1954	2	L	671	316	0	0	0	100	0	0	0.4320	0.0580	0.2000
GREEN RIDGE PWS															
System ID Number	County Location														
MO3010332	PETTIS	1954	2	L	493	191	0	100	0	0	0	0	0.5000	0.0300	0.0500
GREENFIELD PWS															
System ID Number	County Location														
MO5010331	DADE	1910	2	L	1,371	631	0	100	0	0	0	0	0.9210	0.2010	0.2750
GREENVILLE PWS															
System ID Number	County Location														
MO4024637	WAYNE	1971	2	L	520	222	0	100	0	0	0	0	0.1360	0.0580	0.0800
HALE PWS															
System ID Number	County Location														
MO2010338	CARROLL	1955	1	L	480	213	0	0	0	0	100	0			0.0000
HALFWAY PWS															
System ID Number	County Location														
MO5010339	POLK	1992	1	L	173	49	0	100	0	0	0	0		0.0100	0.0000
HALLSVILLE PWS															
System ID Number	County Location														
MO3010340	BOONE	1957	2	L	1,400	497	0	0	0	0	100	0	0.1400	0.0830	0.0000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
HALLTOWN PWS															
System ID Number	County Location														
MO5010341	LAWRENCE	1974	1	L	185	48	0	100	0	0	0	0	2.3040	0.0100	0.0100
HAMILTON PWS															
System ID Number	County Location														
MO1010342	CALDWELL	1923	B2	L	1,813	817	75	0	0	0	25	0	0.2880	0.2100	0.5000
HANNIBAL PWS															
System ID Number	County Location														
MO2010344	MARION	1925	A3	L	17,916	7,673	100	0	0	0	0	0	7.5000	3.2500	5.8840
HARDIN PWS															
System ID Number	County Location														
MO1010346	RAY	1950	2	L	569	248	0	0	0	0	100	0	0.0530	0.0460	0.0500
HARRISBURG PWS															
System ID Number	County Location														
MO3010348	BOONE	1966	2	L	289	136	0	0	0	0	100	0		0.0150	0.0000
HARRISONVILLE PWS															
System ID Number	County Location														
MO1010349	CASS	1930	A2	L	9,400	3,966	100	0	0	0	0	0	1.0940	0.9700	1.3000
HARTVILLE PWS															
System ID Number	County Location														
MO5010351	WRIGHT	1952	2	L	617	307	0	100	0	0	0	0	0.4960	0.0600	0.2300
HAWK POINT PWS															
System ID Number	County Location														
MO6010353	LINCOLN	1960	2	L	669	357	0	100	0	0	0	0	0.3600	0.0500	0.1700
HAYTI HEIGHTS PWS															
System ID Number	County Location														
MO4010959	PEMISCOT	1975	C2	L	741	186	0	100	0	0	0	0	0.4320	0.0580	0.1120
HAYTI PWS															
System ID Number	County Location														
MO4010354	PEMISCOT	1935	C2	L	2,939	1,062	0	100	0	0	0	0	2.5920	0.2820	0.5470

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
HAYWOOD CITY PWS															
System ID Number	County Location														
MO4010971	SCOTT	1976	C2	L	200	56	0	100	0	0	0	0	0.0720	0.0250	0.0160
HENRIETTA PWS															
System ID Number	County Location														
MO1010358	RAY	1957	2	L	356	139	0	0	0	0	100	0			0.0850
HENRY COUNTY WATER COMPANY															
System ID Number	County Location														
MO1010177	HENRY	1984	A3	P	9,014	4,600	100	0	0	0	0	0	2.4000	1.0000	2.4000
HERCULANEUM PWS															
System ID Number	County Location														
MO6010359	JEFFERSON	1942	2	L	3,468	1,534	0	0	0	0	0	100	0.7480	0.4700	0.9000
HERMANN PWS															
System ID Number	County Location														
MO6010360	GASCONADE	1912	2	L	2,500	1,356	0	100	0	0	0	0	1.5000	0.3500	0.5600
HERMITAGE PWS															
System ID Number	County Location														
MO5010361	HICKORY	1959	2	L	458	219	0	100	0	0	0	0	0.7850	0.0730	0.3520
HIGBEE PWS															
System ID Number	County Location														
MO2010362	RANDOLPH	1965	2	L	529	226	0	0	0	100	0	0	0.0700	0.0250	0.0000
HIGGINSVILLE PWS															
System ID Number	County Location														
MO1010363	LAFAYETTE	1890	A2	L	4,797	2,005	100	0	0	0	0	0	1.1600	0.9120	1.6850
HIGH HILL PWS															
System ID Number	County Location														
MO6010364	MONTGOMERY	1964	2	L	300	106	0	100	0	0	0	0	0.1870	0.0400	0.0750
HIGHLANDVILLE PWS															
System ID Number	County Location														
MO5024134	CHRISTIAN	1972	2	L	1,410	556	0	100	0	0	0	0	0.5000	0.0580	0.2650

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
HILLSBORO PWS															
System ID Number	County Location														
MO6010368	JEFFERSON	1950	2	L	3,000	1,224	0	100	0	0	0	0	1.6410	0.4020	0.3500
HOLCOMB PWS															
System ID Number	County Location														
MO4010370	DUNKLIN	1960	2	L	700	324	0	100	0	0	0	0	0.0820	0.0600	0.0500
HOLDEN PWS															
System ID Number	County Location														
MO1010371	JOHNSON	1887	B2	L	2,389	1,077	100	0	0	0	0	0	0.6500	0.2500	0.7500
HOLLAND PWS															
System ID Number	County Location														
MO4010372	PEMISCOT	1964	2	L	239	96	0	0	0	0	100	0	0.1080	0.0350	0.0500
HOLLISTER PWS															
System ID Number	County Location														
MO5010374	TANEY	1931	2	L	4,481	1,610	0	100	0	0	0	0	2.2830	0.9300	1.5220
HOPKINS PWS															
System ID Number	County Location														
MO1010378	NODAWAY	1933	C2	L	532	232	0	100	0	0	0	0	0.1440	0.0380	0.0950
HORNERSVILLE PWS															
System ID Number	County Location														
MO4010379	DUNKLIN	1934	2	L	680	269	0	100	0	0	0	0		0.0400	0.0500
HOUSTON PWS															
System ID Number	County Location														
MO4010382	TEXAS	1935	D2	L	2,081	1,229	0	100	0	0	0	0	2.0950	0.3360	1.0500
HOUSTONIA PWS															
System ID Number	County Location														
MO3010384	PETTIS	1954	C2	L	220	90	0	100	0	0	0	0	0.1500	0.0250	0.0750
HUGHESVILLE PWS															
System ID Number	County Location														
MO3010386	PETTIS	1960	2	L	158	80	0	100	0	0	0	0	0.0860	0.0110	0.0530

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
HUMANSVILLE PWS															
System ID Number	County Location														
MO5010387	POLK	1905	2	L	1,048	402	0	100	0	0	0	0	1.2240	0.1140	0.3500
HUME PWS															
System ID Number	County Location														
MO1010388	BATES	1954	2	L	340	136	0	0	0	100	0	0		0.0180	0.0500
HUMPHREYS PWS															
System ID Number	County Location														
MO2010389	SULLIVAN	1967	1	L	98	41	0	0	0	100	0	0		0.0070	0.0320
HUNNEWELL PWS															
System ID Number	County Location														
MO2010390	SHELBY	1969	1	L	184	82	0	0	0	100	0	0	0.0430	0.0090	0.0400
HUNTSVILLE PWS															
System ID Number	County Location														
MO2010393	RANDOLPH	1950	2	L	1,563	686	0	0	0	100	0	0		0.1080	0.3000
HURLEY PWS															
System ID Number	County Location														
MO5010423	STONE	1993	2	L	178	84	0	100	0	0	0	0	0.0860		0.0210
IBERIA PWS															
System ID Number	County Location														
MO3010396	MILLER	1952	D2	L	736	360	0	100	0	0	0	0	0.9170	0.0680	0.3280
INDEPENDENCE PWS															
System ID Number	County Location														
MO1010399	JACKSON	1925	B3	L	117,240	49,359	0	100	0	0	0	0	36.0000	27.1000	13.1140
IONIA PWS															
System ID Number	County Location														
MO3010400	BENTON	1960	2	L	105	45	0	100	0	0	0	0	0.0850	0.0080	0.0500
IRONDALE PWS															
System ID Number	County Location														
MO6010401	WASHINGTON	1988	2	L	473	189	0	100	0	0	0	0	0.1200	0.0270	0.1050

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
IRONTON PWS															
System ID Number	County Location														
MO4010402	IRON	1928	B2	L	1,450	697	100	0	0	0	0	0	0.2880	0.1240	0.4380
JACKSON PWS															
System ID Number	County Location														
MO4010404	CAPE GIRARDEAU	1907	C3	L	14,386	6,848	0	100	0	0	0	0	2.9520	1.3740	2.1570
JAMESPORT PWS															
System ID Number	County Location														
MO1010406	DAVIESS	1956	2	L	930	331	0	0	0	0	100	0	0.1440	0.0440	0.0000
JAMESTOWN PWS															
System ID Number	County Location														
MO3010407	MONITEAU	1955	2	L	382	180	0	100	0	0	0	0	0.2160	0.0300	0.0500
JASPER PWS															
System ID Number	County Location														
MO5010408	JASPER	1923	2	L	1,011	406	0	100	0	0	0	0	1.1500	0.0850	0.1200
JONESBURG PWS															
System ID Number	County Location														
MO6010412	MONTGOMERY	1958	2	L	768	317	0	100	0	0	0	0	0.3500	0.0750	0.1750
KAHOKA PUBLIC WORKS															
System ID Number	County Location														
MO2010414	CLARK	1930	D2	L	2,165	1,079	0	100	0	0	0	0	0.9360	0.2600	1.1000
KANSAS CITY PWS															
System ID Number	County Location														
MO1010415	JACKSON	1875	A3	L	460,000	175,700	80	20	0	0	0	0	205.0000	112.0000	130.3000
KEARNEY PWS															
System ID Number	County Location														
MO1010416	CLAY	1954	B2	L	9,261	3,461	0	80	0	20	0	0	0.9170	0.6670	1.7950
KELSO PWS															
System ID Number	County Location														
MO4010924	SCOTT	1974	2	L	924	271	0	100	0	0	0	0	0.1440	0.0440	0.0500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
KENNETT PWS															
System ID Number	County Location														
MO4010417	DUNKLIN	1913	B3	L	11,500	4,431	0	100	0	0	0	0	3.0000	1.1000	2.0250
KEYTESVILLE PWS															
System ID Number	County Location														
MO2010420	CHARITON	1936	C2	L	450	260	0	100	0	0	0	0	0.1720	0.0530	0.1770
KIMBERLING CITY OF GOLDEN ACRES PWS															
System ID Number	County Location														
MO5036082	STONE	2006	2	L	50	32	0	100	0	0	0	0	0.0500	0.0040	0.0050
KING CITY PWS															
System ID Number	County Location														
MO1010425	GENTRY	1923	B2	L	1,012	437	100	0	0	0	0	0	0.4320	0.0700	0.2650
KINGDOM CITY PWS															
System ID Number	County Location														
MO3010424	CALLAWAY	1989	2	L	128	94	0	100	0	0	0	0	0.9360	0.0890	0.5000
KINGSTON PWS															
System ID Number	County Location														
MO1010426	CALDWELL	1914	C2	L	340	135	0	100	0	0	0	0	0.0720	0.0310	0.1000
KINGSVILLE PWS															
System ID Number	County Location														
MO1010427	JOHNSON	1960	2	L	250	134	0	0	0	0	100	0	0.0600	0.0400	0.2600
KIRKSVILLE PWS															
System ID Number	County Location														
MO2010429	ADAIR	1924	A3	L	17,304	6,998	100	0	0	0	0	0	6.0000	2.6500	4.2000
KIRKWOOD PWS															
System ID Number	County Location														
MO6010430	ST LOUIS	1923	3	L	28,000	10,343	0	0	0	0	100	0	6.8000	4.0300	0.0000
KNOB NOSTER PWS															
System ID Number	County Location														
MO1010432	JOHNSON	1932	2	L	2,709	1,186	0	100	0	0	0	0	0.6480	0.2900	0.6500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
KOSHKONONG PWS															
System ID Number	County Location														
MO4010434	OREGON	1925	2	L	240	100	0	100	0	0	0	0	0.3450	0.0150	0.0400
LA BELLE PWS															
System ID Number	County Location														
MO2010436	LEWIS	1949	2	L	660	304	0	0	0	100	0	0	0.0700	0.0470	0.1000
LA MONTE PWS															
System ID Number	County Location														
MO3010448	PETTIS	1951	D2	L	1,135	384	0	100	0	0	0	0	0.6400	0.0850	0.1500
LACLEDE PWS															
System ID Number	County Location														
MO2010437	LINN	1959	2	L	345	220	0	0	0	100	0	0	0.0720	0.0300	0.0650
LADDONIA PWS															
System ID Number	County Location														
MO2010438	AUDRAIN	1956	C2	L	511	254	0	100	0	0	0	0	0.1440	0.0380	0.1260
LAGRANGE PWS															
System ID Number	County Location														
MO2010440	LEWIS	1924	C2	L	1,102	410	0	100	0	0	0	0	0.4320	0.1310	0.3750
LAKE LAFAYETTE PWS															
System ID Number	County Location														
MO1031547	LAFAYETTE	2011	2	L	375	130	0	0	0	0	100	0			0.0000
LAKE OZARK PWS															
System ID Number	County Location														
MO3010441	MILLER	1968	2	L	1,586	871	0	100	0	0	0	0	0.1800	0.1000	1.0000
LAKE TAPAWINGO PWS															
System ID Number	County Location														
MO1010980	JACKSON	1935	2	L	863	379	0	0	0	0	100	0		0.0460	0.0000
LAKE WAUKOMIS PWS															
System ID Number	County Location														
MO1010445	PLATTE	1956	2	L	877	439	0	0	0	10	90	0		0.0500	0.0000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
LAKE WINNEBAGO PWS															
System ID Number	County Location														
MO1010880	CASS	1966	D2	L	1,132	520	0	0	0	0	100	0		0.0800	0.3000
LAMAR PWS															
System ID Number	County Location														
MO5010446	BARTON	1931	B3	L	4,659	2,107	100	0	0	0	0	0	1.2500	0.5000	1.2600
LANAGAN PWS															
System ID Number	County Location														
MO5010449	MCDONALD	1948	1	L	420	148	0	100	0	0	0	0	0.4820	0.0880	0.0540
LANCASTER PWS															
System ID Number	County Location														
MO2010450	SCHUYLER	1941	2	L	728	370	0	0	0	100	0	0			0.3500
LAPLATA PWS															
System ID Number	County Location														
MO2010451	MACON	1926	2	L	1,366	569	0	0	0	100	0	0	0.2000	0.0890	0.2000
LAREDO PWS															
System ID Number	County Location														
MO2010452	GRUNDY	1960	1	L	240	85	0	0	0	0	100	0		0.0120	0.0000
LATHROP PWS															
System ID Number	County Location														
MO1010453	CLINTON	1923	2	L	2,898	1,068	0	0	0	80	20	0		0.1860	0.6000
LAURIE PWS															
System ID Number	County Location														
MO3024413	MORGAN	1987	2	L	958	383	0	100	0	0	0	0	0.0600	0.0900	0.3000
LAWSON PWS															
System ID Number	County Location														
MO1010454	RAY	1956	2	L	2,473	962	0	0	0	0	100	0	0.2000	0.1820	0.3500
LEADWOOD PWS															
System ID Number	County Location														
MO4010456	ST FRANCOIS	1971	C2	L	1,300	475	0	100	0	0	0	0	0.2600	0.1300	0.4000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
LEASBURG PWS															
System ID Number	County Location														
MO6010457	CRAWFORD	1957	2	L	300	128	0	100	0	0	0	0	0.1250	0.0150	0.0600
LEBANON PWS															
System ID Number	County Location														
MO5010458	LACLEDE	1889	D3	L	14,300	6,195	0	100	0	0	0	0	4.8630	2.6770	3.0000
LEES SUMMIT PWS															
System ID Number	County Location														
MO1010459	JACKSON	1916	3	L	87,000	35,817	0	0	0	50	50	0		6.9270	34.7200
LEETON PWS															
System ID Number	County Location														
MO1010460	JOHNSON	1950	2	L	620	272	0	100	0	0	0	0	0.4000	0.0450	0.1350
LEVASY PWS															
System ID Number	County Location														
MO1010940	JACKSON	1972	2	L	240	85	0	0	0	0	100	0		0.0280	0.0000
LEWISTOWN PWS															
System ID Number	County Location														
MO2010463	LEWIS	1966	2	L	580	293	0	0	0	100	0	0	0.1580	0.0450	0.1000
LEXINGTON PWS															
System ID Number	County Location														
MO1010464	LAFAYETTE	1884	B2	L	4,300	2,059	100	0	0	0	0	0	1.0000	0.5000	0.8960
LIBERAL PWS															
System ID Number	County Location														
MO5010465	BARTON	1937	D2	L	759	351	0	100	0	0	0	0	0.1920	0.0790	0.1510
LIBERTY PWS															
System ID Number	County Location														
MO1010466	CLAY	1962	A3	L	29,000	10,362	0	100	0	0	0	0	12.0000	2.7000	7.5810
LIBERTY WATER NOEL															
System ID Number	County Location														
MO5010577	MCDONALD	1937	2	P	1,832	666	0	100	0	0	0	0	0.8080	0.4680	0.5400

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
LICKING PWS															
System ID Number	County Location														
MO4010467	TEXAS	1988	2	L	3,124	683	0	100	0	0	0	0	1.6120	0.3150	1.0000
LILBOURN PWS															
System ID Number	County Location														
MO4010468	NEW MADRID	1946	C2	L	1,330	520	0	100	0	0	0	0	1.0440	0.2000	0.3610
LINCOLN PWS															
System ID Number	County Location														
MO3010469	BENTON	1950	2	L	1,100	485	0	100	0	0	0	0	0.5400	0.0900	0.2000
LINN CREEK PWS															
System ID Number	County Location														
MO3010471	CAMDEN	1939	2	L	244	105	0	100	0	0	0	0	0.0700	0.0200	0.1000
LINN PWS															
System ID Number	County Location														
MO3010470	OSAGE	1937	2	L	1,459	623	0	100	0	0	0	0	1.2000	0.0990	0.4500
LINNEUS PWS															
System ID Number	County Location														
MO2010472	LINN	1957	2	L	278	145	0	0	0	0	100	0	0.2160	0.0280	0.0500
LOCKWOOD PWS															
System ID Number	County Location														
MO5010475	DADE	1928	D2	L	936	425	0	100	0	0	0	0	0.8640	0.1020	0.3500
LOUISBURG PWS															
System ID Number	County Location														
MO5011068	DALLAS	1991	D1	L	122	56	0	100	0	0	0	0	0.4240	0.0080	0.0100
LOUISIANA PWS															
System ID Number	County Location														
MO2010479	PIKE	1887	A2	L	3,364	1,613	100	0	0	0	0	0	2.1600	0.7350	2.1610
LOWRY CITY PWS															
System ID Number	County Location														
MO5010480	ST CLAIR	1959	2	L	630	247	0	100	0	0	0	0	0.3670	0.0490	0.1500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MACON PWS															
System ID Number	County Location														
MO2010487	MACON	1890	A3	L	5,489	2,700	100	0	0	0	0	0	4.3200	2.5000	1.5000
MADISON PWS															
System ID Number	County Location														
MO2010488	MONROE	1962	2	L	554	293	0	0	0	100	0	0		0.0320	0.0750
MAITLAND PWS															
System ID Number	County Location														
MO1010489	HOLT	1913	C2	L	320	162	0	100	0	0	0	0	0.0580	0.0220	0.0640
MALDEN PWS															
System ID Number	County Location														
MO4010490	DUNKLIN	1925	2	L	4,275	1,920	0	100	0	0	0	0	1.5000	0.4080	0.6250
MALTA BEND PWS															
System ID Number	County Location														
MO2010491	SALINE	1968	1	L	200	118	0	0	0	0	100	0		0.0240	0.0500
MANSFIELD PWS															
System ID Number	County Location														
MO5010493	WRIGHT	1991	C2	L	1,415	572	0	100	0	0	0	0	0.9210	0.2960	0.3580
MARBLE HILL NORTH PWS															
System ID Number	County Location														
MO4010496	BOLLINGER	1950	2	L	868	314	0	100	0	0	0	0	0.2450	0.0500	0.6740
MARBLE HILL SOUTH PWS															
System ID Number	County Location														
MO4010483	BOLLINGER	1941	2	L	923	312	0	100	0	0	0	0	0.3600	0.0890	0.6740
MARCELINE PWS															
System ID Number	County Location														
MO2010497	LINN	1909	A2	L	2,500	1,108	100	0	0	0	0	0	2.1600	0.5000	0.8000
MARIONVILLE															
System ID Number	County Location														
MO5010499	LAWRENCE	1912	2	P	2,225	920	0	100	0	0	0	0	0.7340	0.1870	0.4000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MARQUAND PWS															
System ID Number	County Location														
MO4010501	MADISON	1968	2	L	200	119	0	100	0	0	0	0	0.0790	0.0260	0.0500
MARSHALL PWS															
System ID Number	County Location														
MO2010502	SALINE	1947	A3	L	13,065	5,095	0	100	0	0	0	0	6.4800	2.6560	6.9920
MARSHFIELD PWS															
System ID Number	County Location														
MO5010503	WEBSTER	1925	2	L	6,791	2,959	0	100	0	0	0	0	3.1460	0.5180	0.8000
MARSTON PWS															
System ID Number	County Location														
MO4010504	NEW MADRID	1962	C2	L	600	236	0	100	0	0	0	0	0.2160	0.0710	0.1500
MARTHASVILLE PWS															
System ID Number	County Location														
MO6010505	WARREN	1956	2	L	1,200	479	0	100	0	0	0	0	0.7200	0.1000	0.1500
MARTINSBURG PWS															
System ID Number	County Location														
MO2010506	AUDRAIN	1965	D2	L	304	176	0	100	0	0	0	0	0.2160	0.0250	0.0500
MARYVILLE PWS															
System ID Number	County Location														
MO1010508	NODAWAY	1882	A3	L	11,972	4,198	100	0	0	0	0	0	5.6000	1.5500	2.5000
MATTHEWS PWS															
System ID Number	County Location														
MO4010509	NEW MADRID	1959	C2	L	625	263	0	100	0	0	0	0	0.2160	0.2110	0.2500
MAYSVILLE PWS															
System ID Number	County Location														
MO1010510	DEKALB	1932	B2	L	1,104	464	100	0	0	0	0	0	0.5760	0.0700	0.2750
MAYVIEW PWS															
System ID Number	County Location														
MO1010511	LAFAYETTE	1962	D2	L	249	144	0	0	0	100	0	0		0.0200	0.2000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MEADVILLE PWS															
System ID Number	County Location														
MO2010512	LINN	1955	C2	L	450	192	0	100	0	0	0	0	0.0720	0.0330	0.0500
MEMPHIS PWS															
System ID Number	County Location														
MO2010513	SCOTLAND	1934	B2	L	1,822	1,021	100	0	0	0	0	0	0.7200	0.1510	0.2500
MENDON PWS															
System ID Number	County Location														
MO2010514	CHARITON	1955	2	L	207	108	0	0	0	100	0	0	0.0250	0.0180	0.1500
MERCER PWS															
System ID Number	County Location														
MO2010515	MERCER	1964	2	L	318	178	0	0	0	0	100	0	0.0720	0.0230	0.0900
MERRIAM WOODS VILLAGE OF PWS															
System ID Number	County Location														
MO5036152	TANEY	1990	2	L	1,750	743	0	100	0	0	0	0	0.7050	0.1300	0.2700
META PWS															
System ID Number	County Location														
MO3010517	OSAGE	1959	2	L	229	109	0	100	0	0	0	0	0.3000	0.0120	0.1000
MIAMI PWS															
System ID Number	County Location														
MO2010520	SALINE	1966	2	L	140	65	0	0	0	0	100	0	0.0430	0.0090	0.0300
MIDDLETOWN PWS															
System ID Number	County Location														
MO6010521	MONTGOMERY	1966	C2	L	167	100	0	100	0	0	0	0	0.0790	0.0160	0.0600
MILAN PWS															
System ID Number	County Location														
MO2010523	SULLIVAN	1922	2	L	1,960	815	0	0	0	100	0	0	0.2000	0.1570	1.0500
MILL SPRING PWS															
System ID Number	County Location														
MO4010527	WAYNE	1957	2	L	189	63	0	100	0	0	0	0	0.1800	0.0390	0.0500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MILLER PWS															
System ID Number	County Location														
MO5010525	LAWRENCE	1935	2	L	680	343	0	100	0	0	0	0	0.5180	0.0700	0.2000
MINDENMINES PWS															
System ID Number	County Location														
MO5010530	BARTON	1964	2	L	340	115	0	100	0	0	0	0	0.1180	0.0280	0.0600
MINER PWS															
System ID Number	County Location														
MO4010531	SCOTT	1969	C2	L	962	437	0	100	0	0	0	0	1.8720	0.2070	0.5750
MINERAL POINT PWS															
System ID Number	County Location														
MO4011123	WASHINGTON	1995	C1	L	359	86	0	100	0	0	0	0		0.0210	0.0650
MISSOURI CITY PWS															
System ID Number	County Location														
MO1010532	CLAY	1966	2	L	250	126	0	0	0	0	100	0		0.0160	0.0230
MO AMERICAN BRUNSWICK															
System ID Number	County Location														
MO2010109	CHARITON	1952	C2	P	858	405	0	100	0	0	0	0	0.4320	0.8400	0.1000
MO AMERICAN JEFFERSON CITY DISTRICT															
System ID Number	County Location														
MO3010409	COLE	1888	A3	P	27,117	10,944	100	0	0	0	0	0	6.5000	3.7530	5.3000
MO AMERICAN JEFFERSON CITY NORTH															
System ID Number	County Location														
MO3010146	CALLAWAY	2017	2	P	95	38	0	100	0	0	0	0	0.3000	0.0230	0.0500
MO AMERICAN JOPLIN															
System ID Number	County Location														
MO5010413	JASPER	1882	A3	P	55,309	24,979	80	20	0	0	0	0	28.6000	12.7580	7.8500
MO AMERICAN MEXICO															
System ID Number	County Location														
MO2010519	AUDRAIN	1885	B3	P	11,543	4,899	0	100	0	0	0	0	4.5000	2.1000	1.5000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MO AMERICAN PLATTE COUNTY															
System ID Number	County Location														
MO1010625	PLATTE	1942	B3	P	12,000	6,082	0	90	0	10	0	0	3.1000	2.2000	3.9500
MO AMERICAN ST JOSEPH															
System ID Number	County Location														
MO1010714	BUCHANAN	1881	A3	P	71,000	32,667	0	100	0	0	0	0	30.0000	17.5000	13.7260
MO AMERICAN ST LOUIS ST CHARLES COUNTIES															
System ID Number	County Location														
MO6010716	ST LOUIS	1902	A3	P	1,100,000	354,059	100	0	0	0	0	0	431.0000	160.0000	115.1100
MO AMERICAN WARDSVILLE															
System ID Number	County Location														
MO3010831	COLE	1967	2	P	1,506	488	0	100	0	0	0	0	0.8640	0.1070	0.2500
MO AMERICAN WARRENSBURG															
System ID Number	County Location														
MO1010833	JOHNSON	1894	B3	P	19,687	7,692	0	100	0	0	0	0	5.0000	2.4000	2.1600
MOBERLY PWS															
System ID Number	County Location														
MO2010533	RANDOLPH	1922	A3	L	13,974	5,310	100	0	0	0	0	0	5.0000	1.1500	1.8100
MOKANE WATER COUNTY OP															
System ID Number	County Location														
MO3010535	CALLAWAY	1961	1	P	208	104	0	100	0	0	0	0	0.2160	0.0200	0.0370
MONETT PWS															
System ID Number	County Location														
MO5010537	BARRY	1890	C2	L	8,935	3,944	0	100	0	0	0	0	6.2000	3.2840	6.8670
MONROE CITY PWS															
System ID Number	County Location														
MO2010538	MONROE	1913	A2	L	2,443	1,216	100	0	0	0	0	0	1.4400	0.3000	1.0600
MONTGOMERY CITY PWS															
System ID Number	County Location														
MO6010539	MONTGOMERY	1906	D3	L	2,712	1,367	0	100	0	0	0	0	1.2000	0.2440	0.8460

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MONTROSE PWS															
System ID Number	County Location														
MO1010541	HENRY	1956	2	L	386	196	0	0	0	100	0	0	0.1440	0.0260	0.0750
MOREHOUSE PWS															
System ID Number	County Location														
MO4010543	NEW MADRID	1939	C2	L	972	385	0	100	0	0	0	0	0.4500	0.1420	0.1500
MORLEY PWS															
System ID Number	County Location														
MO4010945	SCOTT	1974	C2	L	697	320	0	100	0	0	0	0	0.1800	0.0350	0.0840
MORRISON PWS															
System ID Number	County Location														
MO6010544	GASCONADE	1936	2	L	160	66	0	100	0	0	0	0	0.0860	0.0170	0.0570
MORRISVILLE PWS															
System ID Number	County Location														
MO5010545	POLK	1963	2	L	300	169	0	100	0	0	0	0	0.4600	0.0420	0.0500
MOSBY PWS															
System ID Number	County Location														
MO1010546	CLAY	1961	2	L	194	75	0	0	0	0	100	0		0.0190	0.0000
MOSCOW MILLS PWS															
System ID Number	County Location														
MO6010547	LINCOLN	1962	C2	L	2,503	1,022	0	100	0	0	0	0	0.4500	0.3000	0.8500
MOUND CITY PWS															
System ID Number	County Location														
MO1010548	HOLT	1890	C2	L	1,295	570	0	100	0	0	0	0	0.5760	0.1700	0.4000
MOUNT VERNON PWS															
System ID Number	County Location														
MO5010553	LAWRENCE	1897	2	L	4,575	1,906	0	100	0	0	0	0	5.9000	0.6710	1.3000
MOUNTAIN GROVE PWS															
System ID Number	County Location														
MO5010550	WRIGHT	1931	2	L	4,789	1,958	0	100	0	0	0	0	1.7490	0.6020	1.5000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MOUNTAIN VIEW PWS															
System ID Number	County Location														
MO4010551	HOWELL	1938	2	L	2,719	1,159	0	100	0	0	0	0	2.0520	0.2750	1.3500
NAYLOR PWS															
System ID Number	County Location														
MO4010557	RIPLEY	1963	2	L	610	270	0	0	0	0	100	0	0.2880	0.0430	0.2500
NEELYVILLE PWS															
System ID Number	County Location														
MO4010993	BUTLER	1980	2	L	487	228	0	0	0	0	100	0	0.0800	0.0650	0.0500
NELSON PWS															
System ID Number	County Location														
MO2010559	SALINE	1966	1	L	189	75	0	0	0	0	100	0		0.0090	0.0300
NEOSHO PWS															
System ID Number	County Location														
MO5010560	NEWTON	1891	A3	L	12,157	5,119	73	27	0	0	0	0	5.0000	2.1910	4.9000
NEVADA PWS															
System ID Number	County Location														
MO5010562	VERNON	1885	B2	L	8,300	3,666	0	100	0	0	0	0	2.6700	0.8700	1.7000
NEW BLOOMFIELD PWS															
System ID Number	County Location														
MO3010563	CALLAWAY	1961	2	L	669	277	0	100	0	0	0	0	0.3520	0.0420	0.1500
NEW FLORENCE PWS															
System ID Number	County Location														
MO6010565	MONTGOMERY	1956	2	L	769	293	0	100	0	0	0	0	0.6400	0.0700	0.3500
NEW FRANKLIN PWS															
System ID Number	County Location														
MO2010566	HOWARD	1916	2	L	1,089	397	0	0	0	0	100	0	0.2160	0.1000	0.1500
NEW HAMPTON PWS															
System ID Number	County Location														
MO1010567	HARRISON	1969	2	L	283	119	0	0	0	0	100	0	0.0250	0.0170	0.0500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
NEW HAVEN PWS															
System ID Number	County Location														
MO6010568	FRANKLIN	1939	2	L	2,000	946	0	100	0	0	0	0	0.1520	0.2230	0.6000
NEW LONDON PWS															
System ID Number	County Location														
MO2010569	RALLS	1930	2	L	975	494	0	0	0	100	0	0	0.1580	0.0600	0.1250
NEW MADRID PWS															
System ID Number	County Location														
MO4010570	NEW MADRID	1939	C2	L	3,116	1,811	0	100	0	0	0	0	1.4000	0.4500	1.2150
NEWBURG PWS															
System ID Number	County Location														
MO3010887	PHELPS	1943	D2	L	424	210	0	100	0	0	0	0	1.0000	0.0500	0.1250
NEWTOWN PWS															
System ID Number	County Location														
MO2010574	SULLIVAN	1962	1	L	183	69	0	0	0	100	0	0		0.0160	0.0500
NIANGUA PWS															
System ID Number	County Location														
MO5010575	WEBSTER	1967	1	L	405	171	0	100	0	0	0	0	0.1800	0.0250	0.0640
NIXA PWS															
System ID Number	County Location														
MO5010576	CHRISTIAN	1942	D3	L	21,000	8,394	0	100	0	0	0	0	2.2510	1.7820	3.5000
NORBORNE PWS															
System ID Number	County Location														
MO2010578	CARROLL	1930	C2	L	708	322	0	100	0	0	0	0	0.3600	0.0560	0.2200
NORTH KANSAS CITY PWS															
System ID Number	County Location														
MO1010580	CLAY	1912	A2	L	4,800	2,049	0	100	0	0	0	0	5.5000	3.1000	2.0500
NORTHMOOR PWS															
System ID Number	County Location														
MO1010583	PLATTE	1982	2	L	323	155	0	0	0	100	0	0		0.0280	0.0000

City Water Systems

Community Water System Name	System ID Number	County Location	Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
NORWOOD PWS	MO5010585	WRIGHT	1954	2	L	665	267	0	100	0	0	0	0	0.3740	0.0700	0.0770
NOVINGER PWS	MO2010587	ADAIR	1960	2	L	550	205	0	0	0	100	0	0			0.0500
OAK GROVE PWS	MO1010589	JACKSON	1936	2	L	7,681	3,166	0	0	0	0	100	0		0.5750	1.7500
OAK GROVE VILLAGE PWS	MO6010590	FRANKLIN	1964	D2	L	508	128	0	100	0	0	0	0	0.1410	0.0500	0.3900
ODESSA PWS	MO1010599	LAFAYETTE	1922	C2	L	5,300	2,185	0	100	0	0	0	0	1.6000	0.5000	1.6270
OFALLON PWS	MO6010588	ST CHARLES	1940	B3	L	27,000	11,818	0	89	0	11	0	0	6.5000	2.0000	5.6250
ORAN PWS	MO4010604	SCOTT	1937	C2	L	1,294	504	0	100	0	0	0	0	0.2880	0.1660	0.2220
OREGON PWS	MO1010605	HOLT	1912	C2	L	1,371	569	0	100	0	0	0	0	0.4320	0.1550	0.2500
ORONOGO PWS	MO5010606	JASPER	1906	2	L	2,381	959	0	100	0	0	0	0	0.9860	0.3970	0.7000
ORRICK PWS	MO1010607	RAY	1955	2	L	800	340	0	0	0	0	100	0		0.0950	0.1500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
OSAGE BEACH EAST PWS															
System ID Number	County Location														
MO3011367	CAMDEN	2002	D2	L	2,611	1,223	0	100	0	0	0	0	2.4760	0.6410	1.4000
OSAGE BEACH WEST PWS															
System ID Number	County Location														
MO3011346	CAMDEN	2003	D2	L	1,740	1,271	0	100	0	0	0	0	1.8430	0.4760	1.5000
OSBORN PWS															
System ID Number	County Location														
MO1010609	DEKALB	1970	C2	L	450	182	0	100	0	0	0	0	0.0860	0.0280	0.1000
OSCEOLA PWS															
System ID Number	County Location														
MO5010612	ST CLAIR	1900	2	L	947	756	0	100	0	0	0	0	0.6840	0.1700	0.1150
OTTERVILLE PWS															
System ID Number	County Location														
MO3010614	COOPER	1955	2	L	450	208	0	100	0	0	0	0	0.2000	0.0470	0.0000
OWENSVILLE PWS															
System ID Number	County Location														
MO6010618	GASCONADE	1913	2	L	2,800	1,352	0	100	0	0	0	0	1.5000	0.4000	1.0750
OZARK PWS															
System ID Number	County Location														
MO5010619	CHRISTIAN	1929	3	L	18,095	8,494	0	100	0	0	0	0	10.2090	2.6080	4.0580
PACIFIC PWS															
System ID Number	County Location														
MO6010620	FRANKLIN	1912	D2	L	6,000	2,343	0	100	0	0	0	0	2.4480	0.3970	1.4560
PALMYRA PWS															
System ID Number	County Location														
MO2010623	MARION	1914	C2	L	3,595	1,607	0	100	0	0	0	0	1.4400	0.3950	1.0500
PARIS PWS															
System ID Number	County Location														
MO2010624	MONROE	1916	2	L	1,250	613	0	0	0	100	0	0	1.0080	0.0900	0.4100

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
PARK HILLS PWS															
System ID Number	County Location														
MO4010279	ST FRANCOIS	1957	B3	L	9,181	3,139	0	100	0	0	0	0	2.4320	0.9610	2.2130
PARMA PWS															
System ID Number	County Location														
MO4010626	NEW MADRID	1936	C2	L	675	311	0	100	0	0	0	0	0.4320	0.0510	0.2280
PARNELL PWS															
System ID Number	County Location														
MO1010627	NODAWAY	1967	2	L	191	76	0	0	0	100	0	0	0.0300	0.0110	0.0500
PATTONSBURG PWS															
System ID Number	County Location														
MO1010632	DAVIESS	1965	C2	L	348	159	0	100	0	0	0	0	0.0300	0.2400	0.1910
PECULIAR PWS															
System ID Number	County Location														
MO1010633	CASS	1961	2	L	4,608	1,556	0	0	0	100	0	0		0.2450	1.0000
PERRY PWS															
System ID Number	County Location														
MO2010635	RALLS	1936	2	L	694	407	0	0	0	100	0	0	0.1500	0.0590	0.1500
PERRYVILLE PWS															
System ID Number	County Location														
MO4010636	PERRY	1928	A3	L	8,225	3,628	65	35	0	0	0	0	2.6000	1.0900	1.9500
PEVELY PWS															
System ID Number	County Location														
MO6010638	JEFFERSON	1988	2	L	5,400	1,632	0	100	0	0	0	0	2.2820	0.0480	1.9010
PIEDMONT PWS															
System ID Number	County Location														
MO4010640	WAYNE	1926	B2	L	2,726	1,092	100	0	0	0	0	0	0.8640	0.5000	0.6240
PIERCE CITY PWS															
System ID Number	County Location														
MO5010641	LAWRENCE	1886	2	L	1,200	647	0	100	0	0	0	0	2.2750	0.3090	0.2500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
PILOT GROVE PWS															
System ID Number	County Location														
MO3010642	COOPER	1936	D2	L	768	289	0	100	0	0	0	0	0.3450	0.0700	0.0750
PILOT KNOB PWS															
System ID Number	County Location														
MO4010643	IRON	1963	2	L	746	334	0	100	0	0	0	0	0.4300	0.1360	0.2250
PINEVILLE PWS															
System ID Number	County Location														
MO5010645	MCDONALD	1939	2	L	791	380	0	100	0	0	0	0	0.3380	0.1200	0.5580
PLATTE CITY PWS															
System ID Number	County Location														
MO1010646	PLATTE	1930	2	L	4,977	1,920	0	0	0	100	0	0	1.6900	0.6780	1.9480
PLATTSBURG PWS															
System ID Number	County Location														
MO1010648	CLINTON	1939	B2	L	2,966	1,254	100	0	0	0	0	0	1.3540	0.8590	1.8900
PLEASANT HILL PWS															
System ID Number	County Location														
MO1010649	CASS	1911	2	L	7,311	2,890	0	0	0	80	20	0		0.7000	3.2500
PLEASANT HOPE PWS															
System ID Number	County Location														
MO5010650	POLK	1965	2	L	614	278	0	100	0	0	0	0	0.2370	0.0530	0.1650
POLO PWS															
System ID Number	County Location														
MO1010653	CALDWELL	1967	2	L	575	246	0	0	0	0	100	0	0.0750	0.0400	0.0750
POPLAR BLUFF PWS															
System ID Number	County Location														
MO4010656	BUTLER	1930	A3	L	17,266	7,209	100	0	0	0	0	0	6.2000	2.5000	4.8500
PORTAGE DES SIOUX PWS															
System ID Number	County Location														
MO6010657	ST CHARLES	1967	C2	L	345	183	0	100	0	0	0	0	0.0520	0.0330	0.0500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
PORTAGEVILLE PWS															
System ID Number	County Location														
MO4010658	NEW MADRID	1936	C2	L	3,250	1,286	0	100	0	0	0	0	1.4400	0.5500	0.9350
POTOSI PWS															
System ID Number	County Location														
MO6010659	WASHINGTON	1926	2	L	3,000	1,228	0	100	0	0	0	0	1.9000	0.4750	2.0900
PRAIRIE HOME PWS															
System ID Number	County Location														
MO3010660	COOPER	1956	2	L	280	133	0	100	0	0	0	0	0.5470	0.0180	0.0450
PRATHERSVILLE PWS															
System ID Number	County Location														
MO1011067	CLAY	1987	2	L	155	59	0	0	0	0	100	0		0.0160	0.0000
PRINCETON PWS															
System ID Number	County Location														
MO2010664	MERCER	1975	B2	L	1,166	499	0	100	0	0	0	0	0.5180	0.1370	0.5970
PURCELL PWS															
System ID Number	County Location														
MO5010665	JASPER	1911	2	L	408	164	0	100	0	0	0	0		0.0580	0.1000
PURDY PWS															
System ID Number	County Location														
MO5010667	BARRY	1951	2	L	1,100	466	0	100	0	0	0	0	1.2670	0.1150	0.2000
PUXICO PWS															
System ID Number	County Location														
MO4010668	STODDARD	1900	2	L	900	438	0	100	0	0	0	0	0.6260	0.0710	0.2180
QULIN PWS															
System ID Number	County Location														
MO4010670	BUTLER	1965	2	L	450	201	0	100	0	0	0	0	0.2590	0.0330	0.0750
RAVENWOOD PWS															
System ID Number	County Location														
MO1010673	NODAWAY	1962	C2	L	450	179	0	100	0	0	0	0	0.1580	0.0280	0.1560

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
RAYMONDVILLE PWS															
System ID Number	County Location														
MO4010674	TEXAS	1957	2	L	363	153	0	100	0	0	0	0	0.2880	0.0380	0.0500
RAYMORE PWS															
System ID Number	County Location														
MO1010675	CASS	1963	3	L	19,963	7,580	0	0	0	100	0	0		1.4500	1.2600
RAYTOWN WATER COMPANY															
System ID Number	County Location														
MO1010676	JACKSON	1942	3	P	16,390	6,731	0	0	0	80	20	0		1.0790	2.5500
REDINGS MILL PWS															
System ID Number	County Location														
MO5010678	NEWTON	1930	2	L	127	42	0	100	0	0	0	0	0.2280	0.0250	0.0400
REEDS SPRING PWS															
System ID Number	County Location														
MO5010679	STONE	1951	2	L	946	429	0	100	0	0	0	0	0.3350	0.1750	0.3770
REPUBLIC PWS															
System ID Number	County Location														
MO5010681	GREENE	1926	D2	L	16,100	5,913	0	100	0	0	0	0	4.3200	1.3110	2.1000
RHINELAND PWS															
System ID Number	County Location														
MO3011121	MONTGOMERY	1995	2	L	170	71	0	100	0	0	0	0	0.0900	0.0100	0.0900
RICH HILL PWS															
System ID Number	County Location														
MO1010682	BATES	1913	B2	L	1,770	687	100	0	0	0	0	0	0.5040	0.1800	0.1970
RICHLAND PWS															
System ID Number	County Location														
MO3010684	PULASKI	1930	2	L	1,863	902	0	100	0	0	0	0	1.4000	1.2470	0.5750
RICHMOND PWS															
System ID Number	County Location														
MO1010685	RAY	1898	B2	L	5,797	2,596	0	100	0	0	0	0	1.7000	0.7750	2.0500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
RIDGEWAY PWS															
System ID Number	County Location														
MO1010688	HARRISON	1926	2	L	464	187	0	0	0	0	100	0	0.0500	0.0170	0.0500
RISCO PWS															
System ID Number	County Location														
MO4010689	NEW MADRID	1956	D2	L	250	151	0	100	0	0	0	0	0.5040	0.0200	0.0900
ROCK PORT PWS															
System ID Number	County Location														
MO1010696	ATCHISON	1900	2	L	1,266	699	0	0	0	0	100	0	0.7200	0.2630	0.5400
ROCKAWAY BEACH PWS															
System ID Number	County Location														
MO5010697	TANEY	1945	2	L	850	432	0	100	0	0	0	0	0.2370	0.0650	0.2080
ROCKVILLE PWS															
System ID Number	County Location														
MO1010698	BATES	1969	2	L	175	128	0	0	0	100	0	0		0.0270	0.0370
ROGERSVILLE PWS															
System ID Number	County Location														
MO5010699	WEBSTER	1953	2	L	3,213	1,313	0	100	0	0	0	0	0.5970	0.2620	0.4750
ROLLA PWS															
System ID Number	County Location														
MO3010700	PHELPS	1930	C3	L	19,559	7,821	0	100	0	0	0	0	6.5000	2.1850	6.9500
ROSEBUD PWS															
System ID Number	County Location														
MO6010702	GASCONADE	1941	2	L	400	214	0	100	0	0	0	0	0.2400	0.0280	0.0840
ROSENDALE PWS															
System ID Number	County Location														
MO1010757	ANDREW	1970	2	L	140	40	0	0	0	0	100	0	0.0300	0.0230	0.0330
RUSSELLVILLE PWS															
System ID Number	County Location														
MO3010706	COLE	1955	2	L	807	325	0	100	0	0	0	0	0.2000	0.0540	0.2000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
SALEM PWS															
System ID Number	County Location														
MO4010721	DENT	1922	2	L	4,885	2,137	0	100	0	0	0	0	2.2320	0.7260	0.6730
SALISBURY PWS															
System ID Number	County Location														
MO2010722	CHARITON	1956	C2	L	1,620	865	0	100	0	0	0	0	0.5040	0.2000	0.2690
SARCOXIE PWS															
System ID Number	County Location														
MO5010723	JASPER	1908	D2	L	1,354	582	0	100	0	0	0	0	1.0900	0.1600	0.3000
SAVANNAH PWS															
System ID Number	County Location														
MO1010724	ANDREW	1907	C2	L	5,046	2,101	0	100	0	0	0	0	2.1000	0.5000	1.2500
SCHELL CITY PWS															
System ID Number	County Location														
MO5010725	VERNON	1958	2	L	250	120	0	0	0	0	100	0	0.4600	0.0770	0.0000
SCOTT CITY PWS															
System ID Number	County Location														
MO4010726	SCOTT	1937	C2	L	4,565	2,041	0	100	0	0	0	0	0.2500	0.7750	1.1770
SEDALIA PWS															
System ID Number	County Location														
MO3010728	PETTIS	1872	A3	L	21,400	10,094	0	100	0	0	0	0	6.5800	3.5000	5.5000
SEDGEWICKVILLE PWS															
System ID Number	County Location														
MO4010729	BOLLINGER	1967	1	L	176	94	0	100	0	0	0	0	0.0760	0.0110	0.0180
SELIGMAN PWS															
System ID Number	County Location														
MO5010730	BARRY	1953	2	L	850	641	0	100	0	0	0	0	0.8200	0.1000	0.3200
SENATH PWS															
System ID Number	County Location														
MO4010732	DUNKLIN	1926	2	L	1,767	713	0	100	0	0	0	0	0.7200	0.2000	0.0750

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
SENECA PWS															
System ID Number	County Location														
MO5010733	NEWTON	1909	2	L	2,390	905	0	100	0	0	0	0	1.3100	0.7250	0.4160
SEYMOUR PWS															
System ID Number	County Location														
MO5010734	WEBSTER	1927	2	L	1,943	769	0	100	0	0	0	0	0.7920	0.0160	0.2750
SHELBINA PWS															
System ID Number	County Location														
MO2010736	SHELBY	1988	B2	L	1,704	856	100	0	0	0	0	0	1.0000	0.1670	0.3820
SHELBYVILLE PWS															
System ID Number	County Location														
MO2010737	SHELBY	1956	2	L	552	263	0	0	0	100	0	0	0.0650	0.0420	0.0000
SHELDON PWS															
System ID Number	County Location														
MO5010738	VERNON	1951	2	L	543	191	0	100	0	0	0	0	0.5180	0.0400	0.0500
SHERIDAN PWS															
System ID Number	County Location														
MO1010739	WORTH	1949	C2	L	200	94	0	100	0	0	0	0	0.0300	0.0200	0.1000
SIBLEY PWS															
System ID Number	County Location														
MO1010742	JACKSON	1976	2	L	375	170	0	0	0	0	100	0		0.0290	0.0000
SIKESTON PWS															
System ID Number	County Location														
MO4010743	SCOTT	1930	A3	L	16,393	2,645	0	100	0	0	0	0	7.1000	4.9500	3.2300
SILEX PWS															
System ID Number	County Location														
MO6010902	LINCOLN	1969	2	L	206	99	0	100	0	0	0	0	0.0720	0.0300	0.1330
SKIDMORE PWS															
System ID Number	County Location														
MO1010744	NODAWAY	1921	2	L	284	140	0	0	0	100	0	0			0.0500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
SLATER PWS															
System ID Number	County Location														
MO2010745	SALINE	1967	C2	L	1,856	863	0	100	0	0	0	0	0.7200	0.3480	1.4050
SMITHTON PWS															
System ID Number	County Location														
MO3010746	PETTIS	1939	2	L	480	222	0	100	0	0	0	0	0.4320	0.0360	0.0500
SMITHVILLE PWS															
System ID Number	County Location														
MO1010748	CLAY	1927	A2	L	9,233	3,493	100	0	0	0	0	0	2.5000	1.3000	2.4890
SOUTH GREENFIELD PWS															
System ID Number	County Location														
MO5010749	DADE	1967	1	L	100	65	0	100	0	0	0	0	0.2570	0.0080	0.0580
SOUTHWEST CITY PWS															
System ID Number	County Location														
MO5010751	MCDONALD	1935	2	L	976	346	0	100	0	0	0	0	0.3820	0.0750	0.1950
SPARTA PWS															
System ID Number	County Location														
MO5010752	CHRISTIAN	1960	2	L	1,700	829	0	100	0	0	0	0	0.5320	0.1500	0.0800
SPICKARD PWS															
System ID Number	County Location														
MO2010753	GRUNDY	1908	2	L	254	99	0	0	0	100	0	0		0.0280	0.0300
SPRINGFIELD PWS															
System ID Number	County Location														
MO5010754	GREENE	1883	A3	L	175,000	84,539	93	7	0	0	0	0	56.6000	27.5070	18.5500
ST CHARLES PWS															
System ID Number	County Location														
MO6010707	ST CHARLES	1890	A3	L	67,453	26,233	0	43	0	57	0	0	6.0000	3.3000	9.4910
ST CLAIR PWS															
System ID Number	County Location														
MO6010708	FRANKLIN	1932	2	L	4,700	1,691	0	100	0	0	0	0	0.5230	0.4500	1.0000

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
ST ELIZABETH PWS															
System ID Number	County Location														
MO3010709	MILLER	1969	2	L	575	166	0	100	0	0	0	0	0.1000	0.0320	0.1000
ST JAMES PWS															
System ID Number	County Location														
MO3010712	PHELPS	1924	D2	L	4,216	1,740	0	100	0	0	0	0	2.0000	0.4070	0.8000
ST LOUIS CITY PWS															
System ID Number	County Location														
MO6010715	ST LOUIS CITY	1831	A3	L	315,685	22,447	100	0	0	0	0	0	360.0000	154.0000	435.0000
ST MARY PWS															
System ID Number	County Location														
MO4010718	STE GENEVIEVE	1937	2	L	360	173	0	0	0	0	100	0	0.2070	0.0230	0.3250
ST PAUL PWS															
System ID Number	County Location														
MO6011535	ST CHARLES	2006	D2	L	125	50	0	100	0	0	0	0	0.0100	0.0200	0.7500
ST PETERS PWS															
System ID Number	County Location														
MO6010719	ST CHARLES	1960	C3	L	56,971	18,635	0	55	0	45	0	0	4.0000	5.8000	6.5500
ST ROBERT PWS															
System ID Number	County Location														
MO3010720	PULASKI	1960	D2	L	4,340	3,164	0	100	0	0	0	0	0.9000	0.5500	1.5400
STANBERRY PWS															
System ID Number	County Location														
MO1010755	GENTRY	1883	2	L	1,200	608	0	0	0	100	0	0	0.3000	0.1400	0.0000
STE GENEVIEVE PWS															
System ID Number	County Location														
MO4010710	STE GENEVIEVE	1934	B2	L	4,400	1,925	0	100	0	0	0	0	1.5000	0.7910	1.7270
STEELE PWS															
System ID Number	County Location														
MO4010758	PEMISCOT	1938	C2	L	2,200	880	0	100	0	0	0	0	0.7200	1.2300	0.2500

City Water Systems

Community Water System Name	System ID Number	County Location	Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
STEELVILLE PWS	MO6010759	CRAWFORD	1934	2	L	1,642	659	0	100	0	0	0	0	0.9000	0.2500	0.4780
STELLA PWS	MO5010760	NEWTON	1967	2	L	158	78	0	100	0	0	0	0	0.4100	0.0150	0.0500
STEWARTSVILLE PWS	MO1010762	DEKALB	1954	2	L	750	340	0	0	0	0	100	0		0.0410	0.2000
STOCKTON PWS	MO5010763	CEDAR	1936	2	L	1,892	908	0	100	0	0	0	0	0.9500	0.1900	0.3500
STOTTS CITY PWS	MO5010765	LAWRENCE	1930	1	L	225	78	0	100	0	0	0	0	0.5040	0.0180	0.0370
STOVER PWS	MO3010767	MORGAN	1939	2	L	1,623	450	0	100	0	0	0	0	0.3450	0.0850	0.2000
STRAFFORD PWS	MO5010768	GREENE	1967	2	L	2,600	1,187	0	100	0	0	0	0	1.7780	1.6800	0.3000
STURGEON PWS	MO3010771	BOONE	1955	2	L	872	390	0	0	0	0	100	0	0.5000	0.0650	0.0000
SUGAR CREEK PWS	MO1010773	JACKSON	1922	2	L	2,500	996	0	0	0	0	100	0		0.1310	0.0000
SULLIVAN PWS	MO6010775	FRANKLIN	1921	D2	L	7,081	3,388	0	100	0	0	0	0	2.0500	0.7150	1.2580

City Water Systems

Community Water System Name	System ID Number	County Location	Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
SUMMERSVILLE PWS	MO4010777	TEXAS	1961	2	L	502	263	0	100	0	0	0	0	0.6000	0.0610	0.1160
SUNRISE BEACH VILLAGE OF PWS	MO5031591	CAMDEN	2009	2	L	550	220	0	100	0	0	0	0			0.4530
SWEET SPRINGS PWS	MO2010780	SALINE	1905	2	L	1,428	608	0	0	0	100	0	0	0.2880	0.1300	0.2500
SYRACUSE PWS	MO3010783	MORGAN	1955	2	L	172	82	0	100	0	0	0	0	0.1000	0.0200	0.0500
TARKIO BOARD OF PUBLIC WORKS	MO1010786	ATCHISON	1941	2	L	1,583	741	0	0	0	0	100	0	0.7560	0.2250	0.3000
THAYER PWS	MO4010788	OREGON	1912	2	L	2,500	1,060	0	100	0	0	0	0	1.6700	0.6130	0.3200
TINA PWS	MO2010790	CARROLL	1966	1	L	154	76	0	0	0	0	100	0		0.0080	0.0300
TIPTON PWS	MO3010791	MONITEAU	1935	2	L	3,262	977	0	100	0	0	0	0	1.7200	0.3070	0.3500
TRACY PWS	MO1010795	PLATTE	1992	2	L	208	89	0	0	0	100	0	0		0.0110	0.0000
TRENTON MUNICIPAL UTILITIES	MO2010796	GRUNDY	1923	A3	L	6,001	2,731	100	0	0	0	0	0	4.5000	1.7180	166.5920

City Water Systems

Community Water System Name	System ID Number	County Location	Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
TROY PWS	MO6010798	LINCOLN	1932	C2	L	10,500	4,083	0	100	0	0	0	0	2.1510	1.6000	2.0700
TRUESDALE PWS	MO6010799	WARREN	1937	2	L	732	300	0	100	0	0	0	0	0.7560	0.0170	0.2500
UNION PWS	MO6010801	FRANKLIN	1934	D2	L	10,204	4,547	0	100	0	0	0	0	2.5200	0.6620	2.0500
UNION STAR PWS	MO1010802	DEKALB	1989	2	L	437	174	0	0	0	0	100	0		0.0260	0.0500
UNIONVILLE PWS	MO2010804	PUTNAM	1921	B2	L	1,865	945	100	0	0	0	0	0	0.9000	0.2520	0.6130
UNITY VILLAGE	MO1010921	JACKSON	1927	B2	P	1,000	35	100	0	0	0	0	0	0.3300	0.0730	0.1330
URBANA PWS	MO5010807	DALLAS	1962	2	L	409	155	0	100	0	0	0	0	0.3960	0.0360	0.0500
URICH PWS	MO1010808	HENRY	1989	2	L	499	224	0	0	0	100	0	0	0.0830	0.0260	0.0500
VAN BUREN PWS	MO4010811	CARTER	1926	2	L	819	516	0	100	0	0	0	0	0.6480	0.3000	0.1750
VANDALIA PWS	MO2010812	AUDRAIN	1909	B2	L	2,529	1,258	100	0	0	0	0	0	0.7200	0.2200	0.2590

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
VANDUSER PWS															
System ID Number	County Location														
MO4010814	SCOTT	1970	C2	L	298	128	0	100	0	0	0	0	0.0720	0.0150	0.0640
VERSAILLES PWS															
System ID Number	County Location														
MO3010819	MORGAN	1923	2	L	2,465	1,293	0	100	0	0	0	0	1.8300	0.2720	0.5000
VIBURNUM PWS															
System ID Number	County Location														
MO4010821	IRON	1959	2	L	843	305	0	100	0	0	0	0	0.4680	0.0700	0.2200
VIENNA PWS															
System ID Number	County Location														
MO3010822	MARIES	1954	D2	L	610	302	0	100	0	0	0	0	1.0800	0.0620	0.2250
VILLAGE OF UMBER VIEW HEIGHTS PWS															
System ID Number	County Location														
MO5010967	CEDAR	1989	2	L	50	29	0	100	0	0	0	0	0.0250	0.0030	0.0100
VILLAGE OF WEST SULLIVAN PWS															
System ID Number	County Location														
MO4011491	CRAWFORD	2009	1	L	171	102	0	100	0	0	0	0		0.0100	0.1500
WALKER PWS															
System ID Number	County Location														
MO5010828	VERNON	1965	D1	L	283	112	0	100	0	0	0	0	0.1290	0.0200	0.0570
WALNUT GROVE PWS															
System ID Number	County Location														
MO5010829	GREENE	1939	2	L	670	307	0	100	0	0	0	0	0.5760	0.0510	0.0500
WARDELL PWS															
System ID Number	County Location														
MO4010830	PEMISCOT	1962	2	L	477	249	0	100	0	0	0	0	0.0460	0.0330	0.0660
WARRENTON PWS															
System ID Number	County Location														
MO6010834	WARREN	1937	2	L	7,880	3,124	0	100	0	0	0	0	1.8370	0.7880	2.4500

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
WARSAW PWS															
System ID Number	County Location														
MO3010835	BENTON	1931	D2	L	2,130	1,197	0	100	0	0	0	0	1.2000	0.2800	0.7000
WASHBURN PWS															
System ID Number	County Location														
MO5010837	BARRY	1964	2	L	448	213	0	100	0	0	0	0		0.0390	0.1750
WASHINGTON PWS															
System ID Number	County Location														
MO6010838	FRANKLIN	1927	3	L	13,892	6,462	0	100	0	0	0	0	6.3650	2.0420	2.5000
WAVERLY PWS															
System ID Number	County Location														
MO1010839	LAFAYETTE	1941	2	L	800	350	0	0	0	0	100	0	0.2880	0.0540	0.3550
WAYLAND PWS															
System ID Number	County Location														
MO2010840	CLARK	1978	1	L	533	192	0	0	0	0	100	0		0.0180	0.0000
WAYNESVILLE PWS															
System ID Number	County Location														
MO3010841	PULASKI	1942	2	L	5,200	2,441	0	100	0	0	0	0	1.3000	0.4700	1.9250
WEATHERBY LAKE PWS															
System ID Number	County Location														
MO1010842	PLATTE	1966	1	L	1,923	878	0	0	0	100	0	0	0.2000	0.1710	0.3000
WEAUBLEAU PWS															
System ID Number	County Location														
MO5010843	HICKORY	1966	2	L	400	192	0	100	0	0	0	0	0.2660	0.0380	0.0500
WEBB CITY PWS															
System ID Number	County Location														
MO5010844	JASPER	1890	D2	L	10,996	4,616	0	50	0	50	0	0	1.9610	1.3200	1.3210
WELDON SPRING HEIGHTS VILLAGE PWS															
System ID Number	County Location														
MO6010919	ST CHARLES	1941	1	L	100	42	0	100	0	0	0	0	0.2160	0.0360	0.0200

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
WELLINGTON PWS															
System ID Number	County Location														
MO1010846	LAFAYETTE	1939	2	L	812	334	0	0	0	0	100	0		0.0460	0.2000
WELLSVILLE PWS															
System ID Number	County Location														
MO6010848	MONTGOMERY	1930	2	L	1,270	423	0	0	0	100	0	0			0.2000
WENTZVILLE PWS															
System ID Number	County Location														
MO6010849	ST CHARLES	1936	3	L	31,000	13,734	0	0	0	45	55	0	1.3000	2.3000	4.6000
WEST PLAINS PWS															
System ID Number	County Location														
MO4010853	HOWELL	1900	B3	L	12,000	5,565	0	0	100	0	0	0	6.0000	2.1000	5.1950
WESTBORO PWS															
System ID Number	County Location														
MO1010850	ATCHISON	1968	2	L	168	78	0	0	0	100	0	0		0.0100	0.0430
WESTON PWS															
System ID Number	County Location														
MO1010851	PLATTE	1930	C2	L	1,600	806	0	100	0	0	0	0	1.5000	0.3800	1.4230
WHEATLAND PWS															
System ID Number	County Location														
MO5010855	HICKORY	1963	2	L	388	182	0	100	0	0	0	0	0.1360	0.0250	0.0750
WHEATON PWS															
System ID Number	County Location														
MO5010856	BARRY	1941	2	L	698	271	0	100	0	0	0	0	0.3830	0.0500	0.1960
WHEELING PWS															
System ID Number	County Location														
MO2010857	LIVINGSTON	1965	1	L	284	117	0	0	0	0	100	0		0.0200	0.0500
WHITEWATER/ALLENVILLE PWS															
System ID Number	County Location														
MO4011158	CAPE GIRARDEAU	1997	2	L	228	88	0	100	0	0	0	0	0.1720	0.0140	0.1050

City Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
WILLARD PWS															
System ID Number	County Location														
MO5010860	GREENE	1961	2	L	7,903	3,295	0	100	0	0	0	0	0.9000	0.2000	0.8500
WILLIAMSVILLE PWS															
System ID Number	County Location														
MO4010861	WAYNE	1962	2	L	450	220	0	100	0	0	0	0	0.3600	0.0780	0.0850
WILLOW SPRINGS PWS															
System ID Number	County Location														
MO4010862	HOWELL	1925	2	L	2,185	1,097	0	100	0	0	0	0	2.1860	0.4680	0.8900
WINDSOR PWS															
System ID Number	County Location														
MO1010865	HENRY	1911	A3	L	3,044	1,254	0	100	0	0	0	0		0.0160	0.4000
WINFIELD PWS															
System ID Number	County Location														
MO6010866	LINCOLN	1979	2	L	1,700	492	0	0	0	0	100	0	0.4320	0.0210	0.0500
WINONA PWS															
System ID Number	County Location														
MO4010867	SHANNON	1948	2	L	1,335	560	0	100	0	0	0	0	0.4460	1.1400	0.2180
WOOD HEIGHTS PWS															
System ID Number	County Location														
MO1010871	RAY	1957	2	L	717	272	0	0	0	0	100	0		0.0380	0.1000
WRIGHT CITY PWS															
System ID Number	County Location														
MO6010874	WARREN	1939	2	L	3,500	1,667	0	100	0	0	0	0	0.7000	0.2500	0.7480
WYACONDA PWS															
System ID Number	County Location														
MO2010875	CLARK	1962	2	L	227	112	0	0	0	0	100	0	0.1510	0.0110	0.0500
WYATT PWS															
System ID Number	County Location														
MO4010876	MISSISSIPPI	1966	C2	L	428	202	0	100	0	0	0	0	0.0700	0.0200	0.0830

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
ADAIR COUNTY PWSD 1															
System ID Number	County Location														
MO2024000	ADAIR	1975	3	L	7,500	3,048	0	0	0	100	0	0	1.0700	0.5940	0.4890
ANDREW COUNTY PWSD 1															
System ID Number	County Location														
MO1024004	ANDREW	1971	2	L	5,538	2,210	0	0	0	0	100	0		0.5330	0.5260
ANDREW COUNTY PWSD 2															
System ID Number	County Location														
MO1024005	ANDREW	1992	2	L	3,455	1,405	0	0	0	0	100	0	0.3500	0.5040	0.3400
ANDREW COUNTY PWSD 3															
System ID Number	County Location														
MO1024006	ANDREW	1979	1	L	1,780	446	0	0	0	0	100	0		0.0800	0.0000
ANDREW COUNTY PWSD 4															
System ID Number	County Location														
MO1024007	ANDREW	1979	2	L	580	232	0	0	0	0	100	0		0.0370	0.0410
ATCHISON COUNTY PWSD 1															
System ID Number	County Location														
MO1024009	ATCHISON	1974	2	L	753	292	0	0	0	0	100	0	0.1230	0.0730	0.0000
AUDRAIN COUNTY PWSD 1															
System ID Number	County Location														
MO2024013	AUDRAIN	1970	2	L	1,455	662	0	0	0	0	100	0	0.2880	0.1000	0.0750
AUDRAIN COUNTY PWSD 2															
System ID Number	County Location														
MO2024014	AUDRAIN	1971	2	L	2,260	897	0	0	0	0	100	0	1.1080	0.1780	0.1130
BARTON DADE CEDAR JASP COUNTYCONS PWSD 1															
System ID Number	County Location														
MO5024023	BARTON	1967	D2	L	8,641	3,773	0	100	0	0	0	0	2.1700	0.6670	1.1300
BATES COUNTY PWSD 1															
System ID Number	County Location														
MO1024030	BATES	1965	1	L	325	134	0	0	0	100	0	0		0.0260	0.0000

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
BATES COUNTY PWSD 2															
System ID Number	County Location														
MO1024031	BATES	1967	B2	L	1,492	312	100	0	0	0	0	0	0.3960	0.0870	37.3260
BATES COUNTY PWSD 3															
System ID Number	County Location														
MO1024032	BATES	1970	2	L	423	169	0	0	0	100	0	0		0.0280	0.0470
BATES COUNTY PWSD 4															
System ID Number	County Location														
MO1024033	BATES	1975	2	L	2,212	838	0	0	0	100	0	0	0.3000	0.1200	0.3000
BATES COUNTY PWSD 5															
System ID Number	County Location														
MO1024034	BATES	1982	2	L	2,637	1,104	0	0	0	100	0	0		0.1800	0.3000
BATES COUNTY PWSD 6															
System ID Number	County Location														
MO1024035	BATES	1981	2	L	1,712	625	0	0	0	100	0	0		0.1340	0.2000
BATES COUNTY PWSD 7															
System ID Number	County Location														
MO1021160	BATES	1996	2	L	512	205	0	0	0	100	0	0		0.0230	0.0580
BOLLINGER COUNTY PWSD 1															
System ID Number	County Location														
MO4010422	BOLLINGER	1948	2	L	146	77	0	100	0	0	0	0	0.0270	0.0090	0.0150
BOONE COUNTY CONS PWSD 1															
System ID Number	County Location														
MO3024055	BOONE	1966	3	L	21,500	9,019	0	100	0	0	0	0	10.5260	1.5500	3.6220
BOONE COUNTY PWSD 10															
System ID Number	County Location														
MO3024059	BOONE	1972	2	L	4,625	1,880	0	100	0	0	0	0	1.7000	0.4570	0.6500
BOONE COUNTY PWSD 4															
System ID Number	County Location														
MO3024052	BOONE	1967	2	L	6,455	2,711	0	100	0	0	0	0	1.6540	0.5110	1.1000

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
BOONE COUNTY PWSD 9															
System ID Number	County Location														
MO3024058	BOONE	1966	3	L	12,200	5,314	0	100	0	0	0	0	3.5000	1.0900	1.7500
BUCHANAN COUNTY PWSD 1															
System ID Number	County Location														
MO1024064	BUCHANAN	1968	2	L	2,050	817	0	0	0	0	100	0	0.6840	0.1510	0.3470
BUTLER COUNTY PWSD 1															
System ID Number	County Location														
MO4024070	BUTLER	1969	3	L	11,000	4,118	0	100	0	0	0	0	2.9010	0.9000	0.9900
BUTLER COUNTY PWSD 104															
System ID Number	County Location														
MO4021370	BUTLER	2004	2	L	507	203	0	0	0	0	100	0		0.7000	0.0000
BUTLER COUNTY PWSD 2															
System ID Number	County Location														
MO4024071	BUTLER	1969	2	L	1,603	584	0	100	0	0	0	0	0.2880	0.0750	0.1500
BUTLER COUNTY PWSD 3															
System ID Number	County Location														
MO4024072	BUTLER	1972	C2	L	2,600	1,023	0	100	0	0	0	0	0.6260	0.1920	0.4370
CALDWELL COUNTY PWSD 1															
System ID Number	County Location														
MO1024078	CALDWELL	1966	C1	L	460	152	0	100	0	0	0	0	0.0380	0.0240	0.0980
CALDWELL COUNTY PWSD 2															
System ID Number	County Location														
MO1024079	CALDWELL	1970	1	L	665	268	0	0	0	100	0	0		0.0330	0.0750
CALDWELL COUNTY PWSD 3															
System ID Number	County Location														
MO1021318	CALDWELL	2004	2	L	1,452	466	0	0	0	100	0	0	0.2120	0.0860	0.2120
CALLAWAY 2 WATER DISTRICT															
System ID Number	County Location														
MO3024085	CALLAWAY	1973	3	L	13,080	2,294	0	100	0	0	0	0	6.4150	0.7690	1.2890

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CALLAWAY COUNTY PWSD 1															
System ID Number	County Location														
MO3024084	CALLAWAY	1968	D3	L	9,840	4,142	0	100	0	0	0	0	3.2110	0.9950	2.5000
CAMDEN COUNTY PWSD # 5 CEDAR HEIGHTS															
System ID Number	County Location														
MO3031383	CAMDEN	2010	1	L	485	194	0	100	0	0	0	0			0.0300
CAMDEN COUNTY PWSD # 5 CLEARWATER CONDOS															
System ID Number	County Location														
MO3302557	CAMDEN	2003	1	L	550	223	0	100	0	0	0	0		0.0140	0.0270
CAMDEN COUNTY PWSD 1															
System ID Number	County Location														
MO3024090	CAMDEN	1971	2	L	1,165	255	0	100	0	0	0	0	0.2500	0.0230	0.0960
CAMDEN COUNTY PWSD 2															
System ID Number	County Location														
MO3024091	CAMDEN	1975	2	L	1,400	575	0	100	0	0	0	0	0.0930	0.0700	0.2340
CAMDEN COUNTY PWSD 3															
System ID Number	County Location														
MO5021438	CAMDEN	2007	2	L	543	404	0	100	0	0	0	0		0.1300	0.0470
CAMDEN COUNTY PWSD 4 HORSESHOE BEND															
System ID Number	County Location														
MO3021377	CAMDEN	2005	D2	L	5,500	2,107	0	100	0	0	0	0		0.2250	1.7360
CANNON PWSD 1															
System ID Number	County Location														
MO2024500	RALLS	1978	3	L	6,482	2,793	0	0	0	100	0	0	0.7500	0.3480	0.2750
CAPE GIRARDEAU COUNTY PWSD 2															
System ID Number	County Location														
MO4024097	CAPE GIRARDEAU	1967	2	L	2,197	925	0	100	0	0	0	0	0.0290	0.0910	0.3030

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CAPE GIRARDEAU COUNTY PWSD 4															
System ID Number	County Location														
MO4024100	CAPE GIRARDEAU	1974	2	L	1,575	590	0	100	0	0	0	0	0.2340	0.0860	0.1340
CAPE GIRARDEAU COUNTY PWSD 5															
System ID Number	County Location														
MO4021532	CAPE GIRARDEAU	2012	2	L	485	194	0	100	0	0	0	0		0.0150	0.0650
CAPE PERRY COUNTY PWSD 1 SOUTH															
System ID Number	County Location														
MO4024096	CAPE GIRARDEAU	1967	2	L	9,569	2,719	0	100	0	0	0	0	0.5180	0.5320	0.6000
CARROLL COUNTY PWSD 1															
System ID Number	County Location														
MO2024105	CARROLL	1989	C2	L	2,980	1,178	0	100	0	0	0	0	0.7290	0.2020	0.7340
CARTER COUNTY PWSD 1															
System ID Number	County Location														
MO4024108	CARTER	1965	2	L	440	176	0	100	0	0	0	0	0.3600	0.0620	0.1250
CARTER COUNTY PWSD 2															
System ID Number	County Location														
MO4024109	CARTER	1974	2	L	100	36	0	100	0	0	0	0	0.0370	0.0120	0.0120
CASS BATES COUNTY PWSD 12															
System ID Number	County Location														
MO1021098	CASS	1995	2	L	560	505	0	0	0	0	100	0		0.0820	0.2260
CASS COUNTY PWSD 1															
System ID Number	County Location														
MO1024113	CASS	1970	2	L	700	254	0	0	0	100	0	0		0.0300	0.0000
CASS COUNTY PWSD 10															
System ID Number	County Location														
MO1024110	CASS	1983	2	L	3,200	982	0	0	0	100	0	0	0.4500	0.1450	0.4500
CASS COUNTY PWSD 11															
System ID Number	County Location														
MO1021082	CASS	1994	2	L	2,075	699	0	0	0	0	100	0		0.1900	0.4000

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CASS COUNTY PWSD 2															
System ID Number	County Location														
MO1024114	CASS	1972	3	L	3,665	1,485	0	0	0	80	20	0	1.2500	0.5500	1.2500
CASS COUNTY PWSD 3															
System ID Number	County Location														
MO1024115	CASS	1972	2	L	2,736	912	0	0	0	100	0	0		0.1000	1.0000
CASS COUNTY PWSD 4															
System ID Number	County Location														
MO1024116	CASS	1976	2	L	1,768	709	0	0	0	0	100	0		0.1500	0.5580
CASS COUNTY PWSD 5															
System ID Number	County Location														
MO1024117	CASS	1975	2	L	2,670	962	0	0	0	0	100	0		0.1100	0.5000
CASS COUNTY PWSD 6															
System ID Number	County Location														
MO1024112	CASS	1978	2	L	2,307	833	0	0	0	80	20	0	0.2500	0.1580	0.9500
CASS COUNTY PWSD 7															
System ID Number	County Location														
MO1024111	CASS	1990	B2	L	4,307	1,566	100	0	0	0	0	0	1.0000	0.2160	1.3960
CASS COUNTY PWSD 8															
System ID Number	County Location														
MO1024119	CASS	1973	2	L	202	80	0	0	0	100	0	0		0.0100	0.0000
CASS COUNTY PWSD 9															
System ID Number	County Location														
MO1024118	CASS	1977	2	L	5,475	2,219	0	0	0	0	100	0		0.4070	1.0000
CEDAR COUNTY PWSD 1															
System ID Number	County Location														
MO5024120	CEDAR	1970	2	L	1,633	663	0	100	0	0	0	0		0.1400	0.0000
CHARITON COUNTY PWSD 2															
System ID Number	County Location														
MO2024125	CHARITON	1974	2	L	1,078	442	0	0	0	70	30	0	0.1440	0.0490	0.1860

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CHARITON LINN COUNTY PWSD 3															
System ID Number	County Location														
MO2024128	LINN	1976	3	L	5,913	2,381	0	0	0	100	0	0	1.0000	0.4030	0.3880
CHRISTIAN COUNTY PWSD 1															
System ID Number	County Location														
MO5024133	CHRISTIAN	1964	1	L	258	104	0	100	0	0	0	0	0.1940	0.0200	0.1260
CLARK COUNTY CONS PWSD 1															
System ID Number	County Location														
MO2024138	CLARK	1980	C3	L	7,140	2,983	0	100	0	0	0	0	0.8640	0.4170	1.7540
CLAY COUNTY PWSD 2															
System ID Number	County Location														
MO1024142	CLAY	1939	2	L	3,345	1,417	0	0	0	100	0	0	1.0000	0.3490	1.0000
CLAY COUNTY PWSD 3															
System ID Number	County Location														
MO1024143	CLAY	1966	C2	L	3,300	1,334	0	30	0	0	70	0	0.0800	0.1450	0.5600
CLAY COUNTY PWSD 4															
System ID Number	County Location														
MO1024144	CLAY	1966	2	L	970	410	0	0	0	0	100	0		0.1270	0.2500
CLAY COUNTY PWSD 5															
System ID Number	County Location														
MO1024145	CLAY	1966	2	L	1,000	374	0	0	0	100	0	0		0.1330	0.3000
CLAY COUNTY PWSD 6															
System ID Number	County Location														
MO1024146	CLAY	1967	2	L	4,647	1,883	0	0	0	100	0	0		0.3270	0.9000
CLAY COUNTY PWSD 7															
System ID Number	County Location														
MO1024147	CLAY	1970	2	L	283	108	0	0	0	0	100	0		0.0220	0.0000
CLAY COUNTY PWSD 8															
System ID Number	County Location														
MO1024149	CLAY	1975	2	L	2,090	838	0	0	0	80	20	0	1.0080	1.9900	0.2500

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CLAY COUNTY PWSD 9															
System ID Number	County Location														
MO1024150	CLAY	1980	2	L	2,532	852	0	0	0	100	0	0		0.1720	0.5000
CLINTON COUNTY PWSD 1															
System ID Number	County Location														
MO1024153	CLINTON	1967	2	L	957	383	0	0	0	100	0	0	0.2500	0.0590	0.2500
CLINTON COUNTY PWSD 3															
System ID Number	County Location														
MO1024155	CLINTON	1979	2	L	3,410	1,369	0	0	0	100	0	0	0.5000	0.1500	0.5000
CLINTON COUNTY PWSD 4 SYS 1															
System ID Number	County Location														
MO1024156	CLINTON	1985	2	L	5,100	1,807	0	0	0	100	0	0		0.4140	0.9000
CLINTON COUNTY PWSD 4 SYS 2															
System ID Number	County Location														
MO1024154	CLINTON	1974	2	L	750	278	0	0	0	100	0	0		0.0600	0.1000
COLE COUNTY PWSD 1															
System ID Number	County Location														
MO3024159	COLE	1966	D3	L	12,400	5,020	0	100	0	0	0	0	4.0000	1.5950	4.6000
COLE COUNTY PWSD 2															
System ID Number	County Location														
MO3024160	COLE	1966	D3	L	12,600	5,056	0	100	0	0	0	0	4.5500	1.4080	3.9500
COLE COUNTY PWSD 3															
System ID Number	County Location														
MO3024162	COLE	1967	2	L	1,875	726	0	100	0	0	0	0	1.0650	0.1280	0.7000
COLE COUNTY PWSD 4															
System ID Number	County Location														
MO3024163	COLE	1968	D2	L	7,568	1,268	0	100	0	0	0	0	3.7900	0.7170	1.6150
COLE COUNTY PWSD 5															
System ID Number	County Location														
MO3024164	COLE	1969	2	L	260	100	0	100	0	0	0	0	0.1720	0.0180	0.0510

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
COOPER COUNTY CONSOLIDATED PWSD # 1															
System ID Number	County Location														
MO3024170	COOPER	2011	2	L	2,451	833	0	47	0	53	0	0		0.0850	0.1580
COOPER COUNTY PWSD 1															
System ID Number	County Location														
MO3024169	COOPER	1969	2	L	562	227	0	100	0	0	0	0	0.2300	0.0440	0.1010
CRAWFORD COUNTY PWSD 1															
System ID Number	County Location														
MO6036037	CRAWFORD	1986	1	L	160	71	0	100	0	0	0	0	0.1800	0.0070	0.0300
DAVIESS COUNTY PWSD 1															
System ID Number	County Location														
MO1024186	DAVIESS	1972	2	L	2,103	842	0	0	0	0	100	0		0.0990	0.5250
DAVIESS COUNTY PWSD 2															
System ID Number	County Location														
MO1021080	DAVIESS	1994	2	L	2,448	979	0	0	0	33	67	0		0.1090	0.2330
DAVIESS COUNTY PWSD 3															
System ID Number	County Location														
MO1036130	DAVIESS	1970	B3	L	337	642	100	0	0	0	0	0	0.2010	0.0500	0.4750
DEKALB COUNTY PWSD 1															
System ID Number	County Location														
MO1024191	DEKALB	1977	2	L	7,070	2,895	0	0	0	0	100	0		0.7830	0.9340
DENT COUNTY PWSD 1															
System ID Number	County Location														
MO4024196	DENT	1971	2	L	1,500	412	0	100	0	0	0	0	0.2800	0.0980	0.1580
DUNKLIN COUNTY PWSD 1															
System ID Number	County Location														
MO4024206	DUNKLIN	1969	2	L	4,300	1,753	0	100	0	0	0	0	0.7560	1.3160	0.5410
DUNKLIN COUNTY PWSD 2															
System ID Number	County Location														
MO4024207	DUNKLIN	1975	2	L	3,100	882	0	100	0	0	0	0	0.1440	0.1760	0.1500

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
DUNKLIN COUNTY PWSD 3 NORTH															
System ID Number	County Location														
MO4024208	DUNKLIN	1988	1	L	133	46	0	0	0	0	100	0		0.0070	0.0000
DUNKLIN COUNTY PWSD 3 SOUTH															
System ID Number	County Location														
MO4024209	DUNKLIN	1988	2	L	1,500	764	0	100	0	0	0	0	0.4320	0.1540	0.1750
ECM WATER & SEWER AUTHORITY FLINT HILL															
System ID Number	County Location														
MO6011147	ST CHARLES	1995	D2	L	379	151	0	100	0	0	0	0	0.3600	0.0460	0.0750
FRANKLIN COUNTY PWSD 1															
System ID Number	County Location														
MO6024211	FRANKLIN	1967	2	L	3,500	1,444	0	100	0	0	0	0	0.6730	0.3340	0.4400
FRANKLIN COUNTY PWSD 3															
System ID Number	County Location														
MO6024213	FRANKLIN	1971	C3	L	8,250	3,057	0	100	0	0	0	0	1.8000	0.5000	1.2500
FRANKLIN COUNTY PWSD 3 ST ALBANS															
System ID Number	County Location														
MO6079516	FRANKLIN	1948	D2	L	1,300	342	0	100	0	0	0	0	0.7200	0.0500	1.0000
FRANKLIN COUNTY PWSD 4															
System ID Number	County Location														
MO6024214	FRANKLIN	1970	2	L	760	310	0	100	0	0	0	0	0.8790	0.0450	0.0550
GENTRY COUNTY PWSD 1															
System ID Number	County Location														
MO1024223	GENTRY	1971	2	L	2,000	500	0	0	0	0	100	0	0.1400	0.1300	0.2030
GENTRY COUNTY PWSD 2															
System ID Number	County Location														
MO1021221	GENTRY	1997	2	L	900	210	0	0	0	100	0	0	1.0000	0.0340	0.0450
GREENE COUNTY PWSD 1															
System ID Number	County Location														
MO5024228	GREENE	1965	D2	L	8,738	3,580	0	100	0	0	0	0	0.9430	0.2900	1.8000

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
GREENE COUNTY PWSD 5															
System ID Number	County Location														
MO5024230	GREENE	1967	2	L	1,411	626	0	100	0	0	0	0	0.7920	0.1000	0.5650
GREENE COUNTY PWSD 6															
System ID Number	County Location														
MO5024231	GREENE	1969	2	L	485	189	0	100	0	0	0	0	0.2160	0.0400	0.0000
GRUNDY COUNTY PWSD 1															
System ID Number	County Location														
MO2024237	GRUNDY	1971	2	L	3,710	1,530	0	0	0	100	0	0	0.4230	0.3000	0.2540
HARRISON COUNTY PWSD 1															
System ID Number	County Location														
MO1024241	HARRISON	1967	2	L	870	327	0	0	0	0	100	0	0.1000	0.0300	0.1000
HARRISON COUNTY PWSD 2															
System ID Number	County Location														
MO1024242	HARRISON	1988	C2	L	2,950	1,474	0	100	0	0	0	0	0.4600		1.4730
HARRY S TRUMAN PWSD 2															
System ID Number	County Location														
MO1024247	HENRY	1986	B2	L	2,700	929	100	0	0	0	0	0	1.0000	0.7000	0.6430
HENRY COUNTY PWSD 1															
System ID Number	County Location														
MO1021071	HENRY	1994	1	L	255	102	0	0	0	100	0	0		0.0500	0.0000
HENRY COUNTY PWSD 3															
System ID Number	County Location														
MO1021117	HENRY	1997	2	L	2,600	1,066	0	0	0	100	0	0		0.2000	0.5260
HENRY COUNTY PWSD 4															
System ID Number	County Location														
MO1021175	HENRY	1998	2	L	1,055	422	0	0	0	100	0	0			0.2000
HOLT COUNTY PWSD 1															
System ID Number	County Location														
MO1021304	HOLT	2004	2	L	1,020	411	0	0	0	0	100	0	0.3660	0.0440	0.1000

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
HOWARD COUNTY CONS PWSD 1															
System ID Number	County Location														
MO2024259	HOWARD	1971	2	L	2,100	810	0	0	0	0	100	0	0.5040	0.1680	0.4560
HOWARD COUNTY PWSD 2															
System ID Number	County Location														
MO2024261	HOWARD	1973	2	L	1,098	446	0	0	0	0	100	0	0.1160	0.0660	0.0990
HOWELL COUNTY PWSD 1															
System ID Number	County Location														
MO4024264	HOWELL	1967	2	L	840	336	0	100	0	0	0	0	0.4390	0.0800	0.1580
HOWELL COUNTY PWSD 3															
System ID Number	County Location														
MO4021164	HOWELL	1996	1	L	2,000	571	0	100	0	0	0	0	1.0510	0.1300	0.2600
HOWELL OREGON 2 WEST															
System ID Number	County Location														
MO4021376	HOWELL	2002	1	P	912	375	0	100	0	0	0	0	0.5040	0.0550	0.1500
HOWELL OREGON COUNTY PWSD 2 NORTH															
System ID Number	County Location														
MO4024267	HOWELL	1986	1	L	1,896	645	0	100	0	0	0	0	0.4460	0.1050	0.3090
HOWELL OREGON COUNTY PWSD 2 SOUTH															
System ID Number	County Location														
MO4024266	HOWELL	1989	1	L	154	75	0	100	0	0	0	0	0.1580	0.0100	0.0560
JACKSON COUNTY PWSD 1															
System ID Number	County Location														
MO1024275	JACKSON	1938	2	L	24,475	8,596	0	0	0	100	0	0	8.0000	2.5000	8.5000
JACKSON COUNTY PWSD 12															
System ID Number	County Location														
MO1024278	JACKSON	1953	2	L	5,282	2,149	0	0	0	48	52	0		0.3800	1.0000

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
JACKSON COUNTY PWSD 13															
System ID Number	County Location														
MO1024279	JACKSON	1974	2	L	5,905	2,356	0	0	0	0	100	0	1.0000	0.4470	1.0000
JACKSON COUNTY PWSD 15															
System ID Number	County Location														
MO1024281	JACKSON	1991	2	L	7,783	3,006	0	0	0	0	0	100		0.4790	1.9000
JACKSON COUNTY PWSD 16															
System ID Number	County Location														
MO1020869	JACKSON	1993	2	L	3,675	1,476	0	0	0	0	100	0		0.2830	0.9000
JACKSON COUNTY PWSD 17															
System ID Number	County Location														
MO1024282	JACKSON	1976	2	L	2,205	917	0	0	0	0	100	0		0.1410	0.3000
JACKSON COUNTY PWSD 2															
System ID Number	County Location														
MO1024276	JACKSON	1991	3	L	16,500	6,470	0	0	0	100	0	0	2.2000	1.3000	2.0000
JASPER COUNTY PWSD 1															
System ID Number	County Location														
MO5024286	JASPER	1966	2	L	5,500	2,236	0	99	0	1	0	0	1.4110	0.7370	1.2000
JASPER COUNTY PWSD 2															
System ID Number	County Location														
MO5024287	JASPER	1975	D2	L	3,075	1,363	0	100	0	0	0	0	0.2880	0.1890	0.4700
JASPER COUNTY PWSD 3															
System ID Number	County Location														
MO5021252	JASPER	2003	2	L	1,542	516	0	0	0	0	100	0			0.1500
JEFFERSON COUNTY CONS PWSD C 1															
System ID Number	County Location														
MO6024295	JEFFERSON	1972	3	L	35,000	13,545	0	0	0	100	0	0	14.0000	3.5000	5.8000
JEFFERSON COUNTY PWSD 5															
System ID Number	County Location														
MO6024296	JEFFERSON	1968	D3	L	8,000	2,618	0	100	0	0	0	0	0.9730	0.6000	1.5280

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
JEFFERSON COUNTY PWSD 6															
System ID Number	County Location														
MO6024298	JEFFERSON	1967	2	L	7,300	3,018	0	100	0	0	0	0	0.6480	0.5700	1.1500
JEFFERSON COUNTY PWSD 7															
System ID Number	County Location														
MO6024299	JEFFERSON	1968	D2	L	6,100	2,376	0	100	0	0	0	0	2.0000	0.5090	1.6150
JEFFERSON COUNTY PWSD 8															
System ID Number	County Location														
MO6024300	JEFFERSON	1969	D2	L	4,733	1,941	0	100	0	0	0	0	1.3390	0.4000	0.6380
JEFFERSON COUNTY PWSD 1															
System ID Number	County Location														
MO6024292	JEFFERSON	1963	3	L	20,000	7,325	0	0	0	100	0	0		2.3940	2.0000
JEFFERSON COUNTY PWSD 10															
System ID Number	County Location														
MO6024302	JEFFERSON	1971	2	L	10,000	2,686	0	0	0	100	0	0		1.0000	1.1000
JEFFERSON COUNTY PWSD 12															
System ID Number	County Location														
MO6024304	JEFFERSON	1957	2	L	3,000	1,326	0	100	0	0	0	0	0.2300	0.1500	0.9910
JEFFERSON COUNTY PWSD 2															
System ID Number	County Location														
MO6024293	JEFFERSON	1966	A3	L	20,000	6,418	100	0	0	0	0	0	3.0000	1.3000	4.0950
JEFFERSON COUNTY PWSD 3															
System ID Number	County Location														
MO6024294	JEFFERSON	1966	3	L	17,000	7,141	0	0	0	100	0	0		1.7000	3.2500
JOHNSON COUNTY PWSD 1															
System ID Number	County Location														
MO1024309	JOHNSON	1976	2	L	4,554	1,457	0	0	0	0	100	0	0.6000	0.2400	0.6000
JOHNSON COUNTY PWSD 2															
System ID Number	County Location														
MO1024310	JOHNSON	1985	D3	L	13,500	4,349	0	100	0	0	0	0	2.3300	0.3170	2.8300

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
JOHNSON COUNTY PWSD 3															
System ID Number	County Location														
MO1024311	JOHNSON	1971	2	L	4,490	1,708	0	100	0	0	0	0	0.3750	0.2360	0.7450
KNOX COUNTY PUBLIC WATER & SEWER DIST 1															
System ID Number	County Location														
MO2024313	KNOX	1975	2	L	4,298	1,721	0	0	0	100	0	0	0.3700	0.2510	0.4300
LACLEDE COUNTY PWSD 1															
System ID Number	County Location														
MO5024317	LACLEDE	1936	2	L	8,500	2,850	0	100	0	0	0	0	3.4990	0.7920	0.3000
LACLEDE COUNTY PWSD 2															
System ID Number	County Location														
MO5024318	LACLEDE	1968	2	L	657	213	0	100	0	0	0	0	0.1030	0.0350	0.0280
LACLEDE COUNTY PWSD 3															
System ID Number	County Location														
MO5024319	LACLEDE	1972	2	L	5,895	2,444	0	100	0	0	0	0	3.8950	0.5440	2.4640
LAF/JO/SALINE COUNTY CONS PWSD 2															
System ID Number	County Location														
MO1024326	LAFAYETTE	1989	3	L	6,365	2,556	0	0	0	66	34	0		6.0830	1.7100
LAFAYETTE COUNTY PWSD 1															
System ID Number	County Location														
MO1024324	LAFAYETTE	1976	3	L	8,060	3,284	0	0	0	0	100	0		0.7300	2.3500
LEWIS COUNTY PWSD 1															
System ID Number	County Location														
MO2024335	LEWIS	1969	2	L	1,688	678	0	0	0	100	0	0	0.1350	0.1080	0.3800
LINCOLN COUNTY PWSD 1															
System ID Number	County Location														
MO6024340	LINCOLN	1969	C3	L	11,000	4,660	0	100	0	0	0	0	0.8000	0.4800	1.6050
LINCOLN COUNTY PWSD 2															
System ID Number	County Location														
MO6024341	LINCOLN	1978	2	L	1,306	352	0	0	0	0	100	0			0.0000

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
LINN COUNTY CONS PWSD 1															
System ID Number	County Location														
MO2024346	LINN	1969	C2	L	1,620	549	0	100	0	0	0	0	0.1200	0.0850	0.1470
LINN LIVINGSTON COUNTY PWSD 3															
System ID Number	County Location														
MO2024350	LIVINGSTON	1984	C2	L	1,350	565	0	100	0	0	0	0	0.7200	0.1680	0.3340
LIVINGSTON COUNTY PWSD 1															
System ID Number	County Location														
MO2024352	LIVINGSTON	1967	2	L	1,320	614	0	0	0	0	100	0	0.2440	0.0770	0.1570
LIVINGSTON COUNTY PWSD 2															
System ID Number	County Location														
MO2024353	LIVINGSTON	1973	C2	L	2,053	875	0	49	0	0	51	0	0.4320	0.1000	0.2170
LIVINGSTON COUNTY PWSD 3 EAST															
System ID Number	County Location														
MO2024354	LIVINGSTON	1973	2	L	2,087	844	0	0	0	0	100	0	0.4320	0.1960	0.2000
LIVINGSTON COUNTY PWSD 4															
System ID Number	County Location														
MO2024355	LIVINGSTON	1972	C2	L	1,507	603	0	100	0	0	0	0	0.2880	0.1060	0.5120
MACON COUNTY PWSD 1															
System ID Number	County Location														
MO2024363	MACON	1971	3	L	11,606	4,642	0	0	0	100	0	0	1.7330	1.3010	0.5720
MADISON COUNTY PWSD 1 NORTH AND SOUTH															
System ID Number	County Location														
MO4024368	MADISON	1973	2	L	1,938	636	0	100	0	0	0	0	0.1440	0.0630	0.3440
MARIES COUNTY PWSD 1 NORTH															
System ID Number	County Location														
MO3021138	MARIES	1998	1	L	450	211	0	100	0	0	0	0	0.3600	0.0400	0.0500
MARIES COUNTY PWSD 1 SOUTH															
System ID Number	County Location														
MO3021236	MARIES	1998	1	L	200	85	0	100	0	0	0	0	0.0800	0.0180	0.0780

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MARION COUNTY PWSD 1															
System ID Number	County Location														
MO2024377	MARION	1975	2	L	4,900	1,999	0	0	0	60	40	0	0.3450	0.3020	0.4250
MC DONALD COUNTY PWSD 1															
System ID Number	County Location														
MO5024359	MCDONALD	1989	2	L	2,481	863	0	100	0	0	0	0	0.2300	0.1500	0.4800
MC DONALD COUNTY PWSD 2															
System ID Number	County Location														
MO5021113	MCDONALD	1999	2	L	1,300	586	0	100	0	0	0	0	0.9720	0.1200	0.1500
MC DONALD COUNTY PWSD 3															
System ID Number	County Location														
MO5021168	MCDONALD	2004	2	L	600	239	0	100	0	0	0	0			0.0870
MERCER COUNTY PWSD 1															
System ID Number	County Location														
MO2024382	MERCER	1992	3	L	3,195	1,350	0	0	0	82	18	0	0.3450	0.1940	0.2510
MISSISSIPPI COUNTY PWSD 1															
System ID Number	County Location														
MO4021178	MISSISSIPPI	2004	2	L	2,510	1,055	0	0	0	0	100	0		0.1500	0.0000
MO AMERICAN TRI STATE															
System ID Number	County Location														
MO5024601	TANEY	1967	2	P	10,472	2,969	0	100	0	0	0	0	1.1950	0.4000	0.9000
MO ARK WATER CO															
System ID Number	County Location														
MO5024591	STONE	1974	2	L	1,478	605	0	100	0	0	0	0	0.2600	0.1540	0.7860
MONITEAU COUNTY PWSD 1															
System ID Number	County Location														
MO3024395	MONITEAU	1966	2	L	203	75	0	100	0	0	0	0	0.1700	0.0110	0.0500
MONITEAU COUNTY PWSD 2															
System ID Number	County Location														
MO3024396	MONITEAU	1988	1	L	1,325	560	0	100	0	0	0	0		0.1020	0.2000

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MONROE COUNTY PWSD 2															
System ID Number	County Location														
MO2024402	MONROE	1990	2	L	6,677	2,745	0	0	0	100	0	0	0.7200	0.3680	0.3750
MONTGOMERY CO PWSD 1															
System ID Number	County Location														
MO6024406	WARREN	1972	D2	L	4,500	1,307	0	100	0	0	0	0	0.3700	0.0240	0.7000
MONTGOMERY COUNTY PWSD 1 JONESBURG															
System ID Number	County Location														
MO3021326	MONTGOMERY	2000	2	L	300	110	0	0	0	0	100	0	0.2500	0.0080	0.0000
MONTGOMERY COUNTY PWSD 1 MONTGOMERY CITY															
System ID Number	County Location														
MO6024405	MONTGOMERY	2003	1	L	20	47	0	0	0	0	100	0	0.0100	0.0100	0.0000
NEW MADRID COUNTY PWSD # 6															
System ID Number	County Location														
MO4021610	NEW MADRID	2012	1	L	483	193	0	0	0	0	100	0		0.0310	0.0000
NEW MADRID COUNTY PWSD 1															
System ID Number	County Location														
MO4024415	NEW MADRID	1966	1	L	568	206	0	0	0	0	100	0		0.0520	0.0000
NEW MADRID COUNTY PWSD 2															
System ID Number	County Location														
MO4024416	NEW MADRID	1967	1	L	600	191	0	0	0	0	100	0	0.0720	0.0460	0.1000
NEW MADRID COUNTY PWSD 4															
System ID Number	County Location														
MO4024418	NEW MADRID	1972	1	L	420	312	0	0	0	0	100	0		0.0400	0.0600
NEW MADRID COUNTY PWSD 5															
System ID Number	County Location														
MO4024419	NEW MADRID	1997	1	L	1,900	909	0	100	0	0	0	0		0.1690	0.2910

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
NEWTON CO PWSD 1															
System ID Number	County Location														
MO5024423	NEWTON	1967	1	L	450	177	0	100	0	0	0	0	0.2590	0.0350	0.0500
NODAWAY COUNTY PWSD 1															
System ID Number	County Location														
MO1024428	NODAWAY	1975	2	L	6,140	2,519	0	0	0	100	0	0		0.4360	0.6550
NW CASS COUNTY SEWER & WATER DISTRICT															
System ID Number	County Location														
MO1036172	CASS	1989	2	P	835	334	0	0	0	100	0	0	0.0670	0.0650	0.0000
OREGON COUNTY PWSD 1															
System ID Number	County Location														
MO4024432	OREGON	1982	1	L	900	306	0	100	0	0	0	0	0.1290	0.0700	0.0410
OREGON COUNTY PWSD 2															
System ID Number	County Location														
MO4024433	OREGON	1988	1	L	126	42	0	100	0	0	0	0	0.2090	0.0160	0.0260
OSAGE COUNTY PWSD 1															
System ID Number	County Location														
MO3024437	OSAGE	1966	2	L	1,200	406	0	100	0	0	0	0	0.5250	0.0650	0.0660
OSAGE COUNTY PWSD 2 NORTH															
System ID Number	County Location														
MO3024438	OSAGE	1969	2	L	705	234	0	100	0	0	0	0	0.3600	0.0490	0.0800
OSAGE COUNTY PWSD 2 SOUTH															
System ID Number	County Location														
MO3024441	OSAGE	1969	2	L	468	189	0	100	0	0	0	0	0.3960	0.0430	0.0430
OSAGE COUNTY PWSD 3															
System ID Number	County Location														
MO3024439	OSAGE	1975	2	L	1,125	452	0	100	0	0	0	0	0.8350	0.1360	0.3000
OSAGE COUNTY PWSD 4															
System ID Number	County Location														
MO3024440	OSAGE	1974	2	L	358	146	0	100	0	0	0	0	0.2160	0.0230	0.0370

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
OZARK COUNTY PWSD 1															
System ID Number	County Location														
MO5024444	OZARK	1983	2	L	200	213	0	100	0	0	0	0	0.3960	0.0140	0.1560
PEMISCOT COUNTY CON PWSD 1															
System ID Number	County Location														
MO4024448	PEMISCOT	1965	B2	L	5,543	2,134	0	100	0	0	0	0	1.2500	0.6400	0.6400
PERRY COUNTY PWSD 1															
System ID Number	County Location														
MO4024455	PERRY	1966	D2	L	1,970	795	0	100	0	0	0	0	0.3670		0.1550
PERRY COUNTY PWSD 2															
System ID Number	County Location														
MO4024456	PERRY	1976	1	L	700	204	0	0	0	50	50	0	0.1440	0.0500	0.0310
PETTIS/JOHNSON/SALINE PWSD 1															
System ID Number	County Location														
MO3021332	PETTIS	2006	3	L	1,263	421	0	0	0	60	40	0		0.0300	0.0450
PHELPS COUNTY PWSD 1															
System ID Number	County Location														
MO3024465	PHELPS	1967	2	L	800	322	0	100	0	0	0	0	0.0680	0.0400	0.0580
PHELPS COUNTY PWSD 2 NORTH															
System ID Number	County Location														
MO3024466	PHELPS	1975	D2	L	523	209	0	100	0	0	0	0	0.5300	0.0570	0.0660
PHELPS COUNTY PWSD 2 SOUTH															
System ID Number	County Location														
MO3024467	PHELPS	1975	D2	L	1,768	769	0	84	0	0	16	0	0.7000	0.3480	0.3210
PIKE COUNTY PWSD 1															
System ID Number	County Location														
MO2024471	PIKE	1975	3	L	6,655	2,757	0	0	0	100	0	0		0.4900	0.4950
PILOT KNOB RURAL WD 1 DOE RUN AREA															
System ID Number	County Location														
MO4021451	ST FRANCOIS	2007	B2	L	508	351	0	100	0	0	0	0	0.2160	0.0330	0.2060

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
PILOT KNOB RURAL WD 1 N & S															
System ID Number	County Location														
MO4020601	IRON	1992	1	L	637	113	0	0	0	0	100	0		0.0240	0.0660
PLATTE COUNTY CONS PWSD 1															
System ID Number	County Location														
MO1024479	PLATTE	1966	2	L	5,025	1,675	0	0	0	80	20	0		0.3250	0.7640
PLATTE COUNTY PWSD 2															
System ID Number	County Location														
MO1024476	PLATTE	1992	2	L	815	319	0	0	0	80	20	0		0.0490	0.1880
PLATTE COUNTY PWSD 3															
System ID Number	County Location														
MO1024477	PLATTE	1965	2	L	899	364	0	0	0	0	100	0	0.1250	0.0600	0.2680
PLATTE COUNTY PWSD 4															
System ID Number	County Location														
MO1024478	PLATTE	1966	D2	L	9,820	3,520	0	20	0	80	0	0	0.1530	0.7780	1.3540
PLATTE COUNTY PWSD 6															
System ID Number	County Location														
MO1024480	PLATTE	1966	2	L	1,850	750	0	0	0	0	100	0		0.1330	0.5000
PLATTE COUNTY PWSD 7															
System ID Number	County Location														
MO1024481	PLATTE	1970	2	L	1,640	641	0	0	0	0	100	0		0.1300	0.2950
PLATTE COUNTY PWSD 8															
System ID Number	County Location														
MO1024482	PLATTE	1971	2	L	1,176	395	0	0	0	100	0	0	0.0680	0.0870	0.1500
PLATTE COUNTY PWSD 9															
System ID Number	County Location														
MO1024483	PLATTE	1980	2	L	1,485	601	0	0	0	80	20	0		0.1410	0.2000
PULASKI COUNTY PWSD 1															
System ID Number	County Location														
MO3024490	PULASKI	1968	2	L	4,500	1,827	0	97	0	0	3	0	0.9200	0.3900	0.7270

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
PULASKI COUNTY PWSD 2															
System ID Number	County Location														
MO3024491	PULASKI	1980	2	L	7,395	3,116	0	100	0	0	0	0	0.5400	0.5290	1.0000
PULASKI COUNTY PWSD 3															
System ID Number	County Location														
MO3024492	PULASKI	1977	2	L	1,098	446	0	97	0	0	3	0		0.0650	0.2500
PUTNAM COUNTY PWSD 1															
System ID Number	County Location														
MO2024495	PUTNAM	1980	2	L	2,997	1,580	0	0	0	100	0	0	0.4670	0.2280	0.4000
PWSD 2 OF HICKORY CO															
System ID Number	County Location														
MO5021292	HICKORY	2001	2	L	1,280	538	0	100	0	0	0	0			0.1980
PWSD 2 OF STONE COUNTY 265															
System ID Number	County Location														
MO5021421	STONE	2004	2	L	1,125	547	0	100	0	0	0	0	0.9890	0.2050	0.5000
RALLS COUNTY PWSD 1															
System ID Number	County Location														
MO2024499	RALLS	1970	3	L	6,755	2,784	0	0	0	100	0	0	1.0000	0.4560	0.8460
RAY COUNTY CONS PWSD 2															
System ID Number	County Location														
MO1024511	RAY	1969	C2	L	9,212	3,652	0	100	0	0	0	0	3.0000	1.3520	3.8470
RAY COUNTY PWSD 1															
System ID Number	County Location														
MO1024510	RAY	1970	2	L	2,315	937	0	0	0	0	100	0		0.1490	0.7750
RAY COUNTY PWSD 3															
System ID Number	County Location														
MO1024512	RAY	1982	2	L	1,880	755	0	0	0	0	100	0		0.1400	0.3000
RDE WATER COMPANY															
System ID Number	County Location														
MO5048130	CHRISTIAN	1992	2	P	2,855	1,158	0	100	0	0	0	0	1.1800	0.2730	0.2970

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
REYNOLDS COUNTY PWSD 1															
System ID Number	County Location														
MO4024516	REYNOLDS	1966	B2	L	400	101	0	0	100	0	0	0	0.0720	0.0250	0.0770
RIPLEY COUNTY PWSD 1 EAST															
System ID Number	County Location														
MO4024521	RIPLEY	1965	1	L	2,100	909	0	100	0	0	0	0	0.6520	0.1750	0.2250
RIPLEY COUNTY PWSD 1 WEST															
System ID Number	County Location														
MO4024522	RIPLEY	1966	2	L	800	393	0	100	0	0	0	0	1.1410	0.0730	0.2250
RIPLEY COUNTY PWSD 2															
System ID Number	County Location														
MO4024523	RIPLEY	1988	2	L	2,625	1,050	0	100	0	0	0	0	0.5190	0.2540	0.3900
SALINE COUNTY PWSD 1															
System ID Number	County Location														
MO2024555	SALINE	1977	1	L	480	210	0	0	0	0	100	0	0.0800	0.0360	0.0000
SALINE COUNTY PWSD 2															
System ID Number	County Location														
MO2024556	SALINE	1979	1	L	883	424	0	0	0	0	100	0	0.1330	0.0940	0.0000
SALINE COUNTY PWSD 3															
System ID Number	County Location														
MO2024557	SALINE	1983	2	L	2,673	1,098	0	0	0	0	100	0	0.4700	0.2520	0.1150
SCHUYLER COUNTY CONSOLIDATED PWSD 1															
System ID Number	County Location														
MO2024559	SCHUYLER	1965	2	L	3,482	1,359	0	0	0	100	0	0	0.3370	0.2270	0.3110
SCOTLAND COUNTY CONS PWSD 1															
System ID Number	County Location														
MO2024565	SCOTLAND	1986	2	L	3,360	1,384	0	0	0	100	0	0	0.2660	0.2890	0.3000
SCOTT COUNTY PWSD 1															
System ID Number	County Location														
MO4021083	SCOTT	1994	1	L	695	278	0	0	0	0	100	0		0.0660	0.0000

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
SCOTT COUNTY PWSD 2															
System ID Number	County Location														
MO4021151	SCOTT	1997	1	L	500	198	0	0	0	0	100	0	0.0490	0.0490	0.0000
SCOTT COUNTY PWSD 3															
System ID Number	County Location														
MO4021260	SCOTT	1998	1	L	175	70	0	0	0	0	100	0		0.0110	0.0000
SCOTT COUNTY PWSD 4															
System ID Number	County Location														
MO4021566	SCOTT	2010	C1	L	2,275	955	0	100	0	0	0	0	1.0080	0.1450	0.3030
SHELBY COUNTY PWSD 1															
System ID Number	County Location														
MO2024572	SHELBY	1987	2	L	3,120	1,266	0	0	0	100	0	0	0.3030	0.2100	0.4000
SOUTHWEST RURAL WATER DISTRICT 1															
System ID Number	County Location														
MO5021116	BARRY	1999	2	L	1,800	744	0	100	0	0	0	0		0.0200	0.1460
ST CHARLES COUNTY PWSD 2															
System ID Number	County Location														
MO6024530	ST CHARLES	1975	C3	L	100,587	22,539	0	85	0	15	0	0	28.6000	9.6700	18.6000
ST CHARLES COUNTY PWSD 2 AUGUSTA															
System ID Number	County Location														
MO6024531	ST CHARLES	1988	2	L	1,000	314	0	100	0	0	0	0	0.3600	0.0280	0.3200
ST CHARLES COUNTY PWSD 2 DUTZOW															
System ID Number	County Location														
MO6024628	WARREN	1969	2	L	425	149	0	100	0	0	0	0	0.6480	0.0350	0.1440
ST CHARLES COUNTY PWSD 2 WARREN															
System ID Number	County Location														
MO6024629	WARREN	1988	D2	L	1,192	248	0	100	0	0	0	0	0.3020	0.0480	0.7600
ST CHARLES PWSD 2 FORISTELL															
System ID Number	County Location														
MO6010287	ST CHARLES	1986	D2	L	390	217	0	100	0	0	0	0	0.2000	0.0060	1.1750

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
ST FRANCOIS COUNTY PWSD 1															
System ID Number	County Location														
MO4024538	ST FRANCOIS	1970	1	L	150	55	0	100	0	0	0	0	0.0720	0.0080	0.0070
ST FRANCOIS COUNTY PWSD 2															
System ID Number	County Location														
MO4024539	ST FRANCOIS	1975	2	L	830	314	0	100	0	0	0	0	0.0000	0.0600	0.2000
STE GENEVIEVE COUNTY PWSD 1 NORTH															
System ID Number	County Location														
MO4024544	STE GENEVIEVE	1969	2	L	1,263	512	0	100	0	0	0	0	0.2440	0.0890	0.2730
STE GENEVIEVE COUNTY PWSD 1 SC															
System ID Number	County Location														
MO4024543	STE GENEVIEVE	1969	2	L	3,503	1,415	0	100	0	0	0	0	0.6480	0.2820	0.7960
STODDARD COUNTY PWSD 1															
System ID Number	County Location														
MO4024581	STODDARD	1992	C2	L	4,200	1,100	0	100	0	0	0	0	1.0800	0.4030	0.4500
STODDARD COUNTY PWSD 2															
System ID Number	County Location														
MO4024582	STODDARD	1967	1	L	495	167	0	100	0	0	0	0	0.1440	0.0240	0.0500
STODDARD COUNTY PWSD 3															
System ID Number	County Location														
MO4024583	STODDARD	1969	1	L	460	168	0	0	0	0	100	0	0.0820	0.0350	0.0300
STODDARD COUNTY PWSD 4															
System ID Number	County Location														
MO4024584	STODDARD	1992	2	L	1,743	593	0	0	0	0	100	0	0.1770	0.1320	0.2600
STODDARD COUNTY PWSD 5															
System ID Number	County Location														
MO4024585	STODDARD	1971	C2	L	740	294	0	0	0	0	100	0	0.1440	0.1100	0.1100
STODDARD COUNTY PWSD 6															
System ID Number	County Location														
MO4024586	STODDARD	1979	2	L	841	290	0	0	0	0	100	0		0.0390	0.0500

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
STODDARD COUNTY PWSD 7															
System ID Number	County Location														
MO4021592	STODDARD	2010	1	L	208	210	0	0	0	0	100	0		0.0260	0.0000
STONE COUNTY PWSD 1															
System ID Number	County Location														
MO5024590	STONE	1972	2	L	1,900	825	0	100	0	0	0	0	1.1110	0.2790	0.1790
SULLIVAN COUNTY PWSD 1															
System ID Number	County Location														
MO2024594	SULLIVAN	1979	3	L	4,327	1,757	0	0	0	100	0	0	0.4000	0.3200	0.8830
TANEY COUNTY PWSD 1															
System ID Number	County Location														
MO5024599	TANEY	1992	2	L	2,000	779	0	100	0	0	0	0	0.2940	0.1570	0.4830
TANEY COUNTY PWSD 2															
System ID Number	County Location														
MO5024600	TANEY	1992	2	L	4,500	1,940	0	100	0	0	0	0	0.9790	0.1830	1.2430
TANEY COUNTY PWSD 3															
System ID Number	County Location														
MO5024602	TANEY	1989	2	L	5,750	2,409	0	100	0	0	0	0	1.0680	1.1000	2.3630
TEXAS COUNTY PWSD 1															
System ID Number	County Location														
MO4024606	TEXAS	1967	2	L	3,005	1,215	0	100	0	0	0	0	1.4760	0.3250	0.3850
TEXAS COUNTY PWSD 2															
System ID Number	County Location														
MO4024607	TEXAS	1967	2	L	1,638	544	0	100	0	0	0	0	1.2450	0.0770	0.1740
TEXAS COUNTY PWSD 3															
System ID Number	County Location														
MO4024608	TEXAS	1990	2	L	765	255	0	100	0	0	0	0	0.5040	0.1050	0.0620
TEXAS COUNTY PWSD 4															
System ID Number	County Location														
MO4024609	TEXAS	1990	2	L	3,000	715	0	100	0	0	0	0	1.0650	0.1840	0.3960

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
THOMAS HILL PWSD 1															
System ID Number	County Location														
MO2024504	RANDOLPH	1983	3	L	10,315	4,153	0	0	0	100	0	0	1.2240	0.5990	2.2610
VERNON COUNTY CONS PWSD 1															
System ID Number	County Location														
MO5024618	VERNON	1968	D2	L	8,280	3,383	0	100	0	0	0	0	2.0000	0.8410	1.5330
VERNON COUNTY PWSD 2															
System ID Number	County Location														
MO5024617	VERNON	1966	D2	L	1,175	467	0	100	0	0	0	0	0.3310	0.1150	0.2500
VERNON COUNTY PWSD 7															
System ID Number	County Location														
MO5024622	VERNON	1972	1	L	550	215	0	0	0	100	0	0	0.0820	0.0410	0.0400
VILLAGE OF PRESTON WATER DEPT															
System ID Number	County Location														
MO5024250	HICKORY	1991	1	L	213	95	0	100	0	0	0	0	0.1800	0.0120	0.0100
WASHINGTON COUNTY PWSD 1															
System ID Number	County Location														
MO6024633	WASHINGTON	1988	2	L	700	197	0	0	0	0	100	0		0.0210	0.0000
WASHINGTON COUNTY PWSD 2															
System ID Number	County Location														
MO4021447	WASHINGTON	2012	2	L	200	68	0	100	0	0	0	0	0.1800	0.0080	0.0750
WAYNE & BUTLER COUNTY PWSD 4															
System ID Number	County Location														
MO4021311	WAYNE	2003	2	L	1,500	655	0	100	0	0	0	0		0.2670	0.2200
WAYNE COUNTY PWSD 2															
System ID Number	County Location														
MO4021310	WAYNE	2004	2	L	900	247	0	100	0	0	0	0	0.1000	0.0400	0.2000
WAYNE COUNTY PWSD 3															
System ID Number	County Location														
MO4021384	WAYNE	2004	1	L	287	116	0	0	0	0	100	0		0.0170	0.0000

Water District Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
WORTH COUNTY PWSD 1															
System ID Number	County Location														
MO1024646	WORTH	1981	2	L	1,368	538	0	0	0	100	0	0	2.0000	0.0670	0.2200
WRIGHT COUNTY PWSD 1															
System ID Number	County Location														
MO5024650	WRIGHT	1989	2	L	483	198	0	100	0	0	0	0	0.2520	0.0240	0.0510

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
10 4 WATER SYSTEM															
System ID Number	County Location														
MO5031436	MORGAN	2004	2	P	150	85	0	100	0	0	0	0		0.0120	0.0000
5 81 MOTEL & CAMPGROUND															
System ID Number	County Location														
MO3190771	CAMDEN	1962	1	P	75	21	0	100	0	0	0	0			0.0000
A&H COUNTRY ESTATES															
System ID Number	County Location														
MO6048200	JEFFERSON	1965	1	P	80	26	0	100	0	0	0	0	0.0290	0.0040	0.0000
ACRES OF SHADE MHP															
System ID Number	County Location														
MO5048082	GREENE	1970	1	P	50	45	0	100	0	0	0	0	0.1300	0.0100	0.0060
AGAPE BOARDING SCHOOL															
System ID Number	County Location														
MO5172802	CEDAR	2006	1	P	250	32	0	100	0	0	0	0		0.0070	0.0010
AIRPORT HOMEOWNERS ASSN INC															
System ID Number	County Location														
MO5031435	BARRY	2004	1	P	50	25	0	100	0	0	0	0		0.0030	0.0000
ALLEN ACRES															
System ID Number	County Location														
MO6040116	LINCOLN	1992	1	P	70	46	0	100	0	0	0	0		0.0050	0.0050
ALTA VISTA MOBILE VILLA															
System ID Number	County Location														
MO3048125	PHELPS	1970	1	P	60	27	0	100	0	0	0	0	0.0350	0.0020	0.0000
ANTHONIES MILL RESORT SUBDIVISION															
System ID Number	County Location														
MO4036311	WASHINGTON	1990	1	P	200	76	0	100	0	0	0	0	0.0860	0.0100	0.0480
ANTIRE VALLEY SUBD															
System ID Number	County Location														
MO6036274	JEFFERSON	1983	1	P	260	80	0	100	0	0	0	0	0.0500	0.0250	0.0190

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name	System ID Number	County Location	Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
APPLE VALLEY COURT	MO5040637	CHRISTIAN	1997	1	P	25	11	0	100	0	0	0	0		0.0020	0.0000
ARGYLE ESTATES WATER SUPPLY	MO6036126	FRANKLIN	1971	1	P	120	52	0	100	0	0	0	0	0.0100	0.0100	0.0120
ARROW RIDGE SHORES	MO3031133	CAMDEN	1997	1	P	125	52	0	100	0	0	0	0	0.2600	0.0050	0.0150
ATCHISON COUNT WHOLESALE WATER COMMISSIO	MO1021595	ATCHISON	2013	C2	P	25	4	0	100	0	0	0	0	0.4800	0.4200	0.9300
AVERY MOBILE HOME COURT	MO6048068	FRANKLIN	1964	1	P	110	46	0	100	0	0	0	0	0.0100	0.0050	0.0000
BAISCH NURSING CENTER	MO6069045	JEFFERSON	1990	1	P	189	1	0	100	0	0	0	0	0.0040	0.0070	0.0050
BALD EAGLE WELL LLC	MO5301471	TANEY	2013	1	P	48	4	0	100	0	0	0	0	0.0930	0.0030	0.0000
BALLERINA PARK HOME COMMUNITY	MO1041186	LAFAYETTE	1997	1	P	173	66	0	0	0	0	100	0		0.0160	0.0000
BAPTIST HOME	MO4069075	IRON	1988	2	P	80	3	0	100	0	0	0	0	0.0860	0.0110	0.1100
BARRY COUNTY PWSD 2	MO5036196	BARRY	1990	2	L	155	73	0	100	0	0	0	0	0.1220	0.0070	0.0200

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
BEACH CLUB CONDO ASSN															
System ID Number	County Location														
MO3302314	MILLER	1997	2	P	65	26	0	100	0	0	0	0	0.3600	0.0040	0.0110
BELLEVIEW VALLEY NURSING HOME															
System ID Number	County Location														
MO4069040	IRON	1990	C1	P	106	2	0	100	0	0	0	0	0.0280	0.0110	0.0290
BENDCO COVE															
System ID Number	County Location														
MO5031454	MORGAN	2005	2	P	50	48	0	100	0	0	0	0		0.0060	0.0000
BENNINGTON ESTATES															
System ID Number	County Location														
MO6031248	LINCOLN	2004	1	P	185	54	0	100	0	0	0	0		0.0070	0.0100
BIG COUNTRY ACRES SUBDIVISION															
System ID Number	County Location														
MO6030662	ST CHARLES	1993	1	P	90	29	0	100	0	0	0	0		0.0020	0.0040
BIG ISLAND WATER COMPANY															
System ID Number	County Location														
MO3031265	CAMDEN	2001	C1	P	175	66	0	100	0	0	0	0			0.0890
BIG RIVER HILLS LLC															
System ID Number	County Location														
MO4036173	ST FRANCOIS	1969	1	P	47	26	0	100	0	0	0	0	0.0720	0.0050	0.0060
BIG VALLEY COURT															
System ID Number	County Location														
MO6041162	JEFFERSON	1996	2	P	23	15	0	100	0	0	0	0		0.0010	0.0000
BIG VALLEY PARK MHP															
System ID Number	County Location														
MO5048225	NEWTON	1989	2	P	158	53	0	100	0	0	0	0		0.0110	0.0150
BILYEU RIDGE WATER COMPANY LLC															
System ID Number	County Location														
MO5036027	CHRISTIAN	1990	2	P	135	60	0	100	0	0	0	0	0.0720	0.0090	0.0140

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
BLACK FOREST HOA INC NO 2															
System ID Number	County Location														
MO3031167	GASCONADE	2002	1	P	50	23	0	100	0	0	0	0		0.0030	0.0200
BLACKHAWK ESTATES															
System ID Number	County Location														
MO3036103	CAMDEN	1961	1	P	100	50	0	100	0	0	0	0		0.0070	0.0000
BLOCK SIX WATER ASSN															
System ID Number	County Location														
MO6036207	JEFFERSON	1991	1	P	50	24	0	100	0	0	0	0	0.0200	0.0020	0.0000
BLUE ACRES MHP															
System ID Number	County Location														
MO2041563	BOONE	2009	1	P	275	103	0	0	0	0	100	0			0.0000
BLUE ANCHOR BAY CONDOMINIUMS															
System ID Number	County Location														
MO5301489	MORGAN	2007	2	P	150	101	0	100	0	0	0	0			0.0460
BLUE BRANCH IMPROVEMENT ASSN INC															
System ID Number	County Location														
MO3036123	BENTON	1969	2	P	200	102	0	100	0	0	0	0	0.0300	0.0180	0.0180
BLUE RIDGE ESTATES SUBD															
System ID Number	County Location														
MO5031298	TANEY	2018	1	P	34	17	0	100	0	0	0	0	0.0280	0.0020	0.0000
BLUE STEM ESTATES SUBD															
System ID Number	County Location														
MO5031330	CHRISTIAN	2000	1	P	26	12	0	100	0	0	0	0	0.0280		0.0000
BLUE WATER VILLAGE/ BLAKEWOOD SUBD															
System ID Number	County Location														
MO5031128	STONE	1995	2	P	70	28	0	100	0	0	0	0	0.0900	0.0030	0.0040
BOHANNA HEIGHTS SUBDIVISION															
System ID Number	County Location														
MO5251522	HICKORY	2006	2	P	40	30	0	100	0	0	0	0			0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
BOLIVAR SOUTHTOWN UTILITIES COMPANY INC															
System ID Number	County Location														
MO5031408	POLK	2004	2	P	300	173	0	100	0	0	0	0	1.0650	0.0470	0.0420
BONNE TERRE PRISON															
System ID Number	County Location														
MO4061410	ST FRANCOIS	2006	C2	S	3,500	1	0	100	0	0	0	0		0.2500	0.5000
BOURBEUSE MHP															
System ID Number	County Location														
MO6048103	FRANKLIN	1970	1	P	70	25	0	100	0	0	0	0	0.0360	0.0060	0.0000
BRADEN PARK VILLAGE															
System ID Number	County Location														
MO3041351	BENTON	2011	1	P	157	61	0	0	0	0	100	0		0.0060	0.0000
BRANSON CREEK DEVELOPMENT LLC															
System ID Number	County Location														
MO5031223	TANEY	2001	2	P	175	168	0	100	0	0	0	0	2.1600	0.3800	0.5000
BRANSON VIEW ESTATES															
System ID Number	County Location														
MO5041212	TANEY	1997	2	P	113	45	0	100	0	0	0	0	1.7280	0.0090	0.0900
BRIAR CLIFF SUBDIVISION															
System ID Number	County Location														
MO5031104	STONE	1995	2	P	165	66	0	100	0	0	0	0			0.0030
BRIARWOOD & REDBUD SHORES WATER ASSOC															
System ID Number	County Location														
MO5301550	TANEY	2009	2	P	32	4	0	100	0	0	0	0	0.1200		0.0180
BRIARWOOD UTILITIES															
System ID Number	County Location														
MO6031110	JEFFERSON	1995	2	P	160	94	0	100	0	0	0	0	0.1150	0.0150	0.0050

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
BRIDGEPORT 1ST ADDITION															
System ID Number	County Location														
MO5031420	STONE	2004	2	P	39	40	0	100	0	0	0	0	0.0170		0.0000
BROOK HILL SUBDIVISION															
System ID Number	County Location														
MO6031387	LINCOLN	2004	1	P	65	28	0	100	0	0	0	0	0.1080	0.1080	0.0040
BROOKVIEW APARTMENTS															
System ID Number	County Location														
MO3079510	MILLER	1984	2	P	180	72	0	100	0	0	0	0			0.0000
BUELAH LAND ESTATES															
System ID Number	County Location														
MO6251637	LINCOLN	2016	1	P	25	27	0	100	0	0	0	0			0.0000
BULL CREEK VILLAGE															
System ID Number	County Location														
MO5048161	TANEY	1992	2	L	603	65	0	100	0	0	0	0	0.3330	0.0460	0.1260
BYBEE ESTATES															
System ID Number	County Location														
MO5031605	POLK	2009	2	P	75	24	0	100	0	0	0	0	0.1440		0.0000
CAMDEN COUNTY PWSD #4 SHAWNEE BEND															
System ID Number	County Location														
MO3031201	CAMDEN	1997	2	L	1,200	696	0	100	0	0	0	0	0.2000	0.1600	0.2000
CAMDEN PLACE APARTMENTS															
System ID Number	County Location														
MO3079511	CAMDEN	2005	2	P	96	33	0	100	0	0	0	0			0.0000
CAMELOT ESTATES MHP															
System ID Number	County Location														
MO4048181	BUTLER	1972	1	P	27	18	0	100	0	0	0	0	0.0720		0.0000
CANYON FOREST EAST AND WEST															
System ID Number	County Location														
MO5031303	STONE	1999	1	P	40	27	0	100	0	0	0	0			0.0030

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CAPE FAIR ESTATES															
System ID Number	County Location														
MO5031343	STONE	2001	2	P	113	45	0	100	0	0	0	0			0.0010
CAPS COVE SUBD															
System ID Number	County Location														
MO5031172	STONE	1996	2	P	30	21	0	100	0	0	0	0	0.0340		0.0050
CAROLINA OAKS PLANTATION															
System ID Number	County Location														
MO4031320	CAPE GIRARDEAU	2002	2	P	157	45	0	100	0	0	0	0	0.0100	0.0090	0.0100
CATAMOUNT RIDGE PROPERTY OWNERS ASSOC															
System ID Number	County Location														
MO5031136	STONE	1995	2	P	113	45	0	100	0	0	0	0	0.0400	0.0080	0.0140
CEDAR COVE PARK SUBD															
System ID Number	County Location														
MO5031097	STONE	1995	2	P	30	26	0	100	0	0	0	0		0.0030	0.0030
CEDAR GLEN CONDOMINIUMS															
System ID Number	County Location														
MO3071205	CAMDEN	1998	2	P	535	214	0	100	0	0	0	0		0.0250	0.0350
CEDAR GREEN LAND ACQUISITION LLC															
System ID Number	County Location														
MO3190757	CAMDEN	2007	2	P	110	54	0	100	0	0	0	0			0.0590
CEDAR GROVE VILLAGE SUBD															
System ID Number	County Location														
MO6036189	WARREN	1990	1	P	90	26	0	100	0	0	0	0			0.0000
CEDAR HILL APTS															
System ID Number	County Location														
MO5079527	CHRISTIAN	1985	1	P	102	34	0	100	0	0	0	0		0.0020	0.0000
CEDAR HILL ESTATES WATER															
System ID Number	County Location														
MO6048252	JEFFERSON	1977	1	P	490	185	0	100	0	0	0	0	0.2880	0.0400	0.0510

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CEDAR HILL LAKES VILLAGE															
System ID Number	County Location														
MO6010970	JEFFERSON	1952	1	L	65	34	0	100	0	0	0	0	0.2880	0.0110	0.0010
CEDAR KNOLL HOME															
System ID Number	County Location														
MO3060800	PHELPS	1994	1	P	28	1	0	100	0	0	0	0		0.0020	0.0000
CEDAR SHORES RANCH ESTATES															
System ID Number	County Location														
MO5031398	TANEY	2005	2	P	38	42	0	100	0	0	0	0	0.1080	0.0080	0.0270
CEDAR SPRINGS MHP INC															
System ID Number	County Location														
MO5041130	STONE	1995	1	P	30	22	0	100	0	0	0	0	0.0760	0.0030	0.0050
CEDARIDGE ESTATES															
System ID Number	County Location														
MO5036048	STONE	1969	2	P	197	78	0	100	0	0	0	0	0.1050	0.0140	0.0600
CENTRAL CROSSING ACRES II															
System ID Number	County Location														
MO5031380	BARRY	2003	2	P	25	35	0	100	0	0	0	0			0.0100
CENTRAL MO CRRCTNL CTR															
System ID Number	County Location														
MO3069008	COLE	1989	2	S	31	1	0	100	0	0	0	0	0.3200	0.0090	0.0120
CHAMPION FARMS SUBDIVISION															
System ID Number	County Location														
MO6030021	LINCOLN	2017	1	P	30	9	0	100	0	0	0	0			0.0010
CHAPEL HILL SUBD															
System ID Number	County Location														
MO5190909	CEDAR	1992	2	P	32	22	0	100	0	0	0	0			0.0100
CHELSEA ROSE SUBD															
System ID Number	County Location														
MO3031244	CAMDEN	1998	1	P	78	36	0	100	0	0	0	0			0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CHRISTIAN ASSOCIATES OF TABLE ROCK LAKE															
System ID Number	County Location														
MO5191413	STONE	1995	2	P	80	39	0	100	0	0	0	0			0.0320
CIMARRON BAY SUBDIVISION															
System ID Number	County Location														
MO3031290	CAMDEN	1999	1	P	160	92	0	100	0	0	0	0		0.0050	0.0350
CIRCLE C MOBILE HOME PARK															
System ID Number	County Location														
MO6048106	FRANKLIN	1971	1	P	90	31	0	100	0	0	0	0		0.0050	0.0000
CITYDEL MHP															
System ID Number	County Location														
MO5040555	CHRISTIAN	1993	1	P	32	15	0	100	0	0	0	0	0.0540		0.0000
CLARENCE CANNON WHOLESALE WTR COMM															
System ID Number	County Location														
MO2020421	MONROE	1992	A3	L	25	49	100	0	0	0	0	0	10.0000	4.2930	7.9250
CLEAR COVE LANDING															
System ID Number	County Location														
MO5031335	STONE	2004	2	P	55	40	0	100	0	0	0	0			0.0250
CLEAR WATER ACRES SUBD															
System ID Number	County Location														
MO5036191	TANEY	1988	2	P	175	99	0	100	0	0	0	0		0.0200	0.0200
CLETS TRAILER PARK															
System ID Number	County Location														
MO4048184	BUTLER	1988	1	P	30	11	0	100	0	0	0	0	0.0280	0.0030	0.0000
CLEVENGER BRANCH MEMBERS CORP															
System ID Number	County Location														
MO5240145	TANEY	1991	2	P	150	60	0	100	0	0	0	0	0.0860		0.0060

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
COACHLIGHT VILLAGE MHP															
System ID Number	County Location														
MO5048173	STONE	1991	2	P	100	68	0	100	0	0	0	0	0.0640	0.0100	0.0050
COLE TURKEY ACRES															
System ID Number	County Location														
MO3036260	BENTON	1965	2	P	150	217	0	100	0	0	0	0	0.0470	0.0300	0.0120
COLLEGE OF THE OZARKS															
System ID Number	County Location														
MO5069033	TANEY	1946	B3	P	1,700	59	100	0	0	0	0	0	0.4320	0.1580	0.2300
COLONY COVE MHP															
System ID Number	County Location														
MO5048264	GREENE	1967	1	P	210	84	0	100	0	0	0	0	0.0500	0.0110	0.0200
COMMUNITY WATER SYSTEM															
System ID Number	County Location														
MO4036064	WAYNE	1974	2	P	750	125	0	100	0	0	0	0			0.0140
CORNER WATER COMPANY															
System ID Number	County Location														
MO4036307	WAYNE	1976	1	P	75	26	0	100	0	0	0	0		0.0070	0.0030
COUNTRY ACRES MOBILE HOME PARK															
System ID Number	County Location														
MO3041361	BENTON	2002	1	P	40	25	0	100	0	0	0	0			0.0000
COUNTRY ACRES SUBD															
System ID Number	County Location														
MO1036167	JOHNSON	1971	1	P	130	52	0	100	0	0	0	0	0.0300	0.0100	0.0110
COUNTRY AIRE APARTMENTS															
System ID Number	County Location														
MO5071593	DOUGLAS	2008	2	P	25	20	0	100	0	0	0	0	0.0210	0.0020	0.0000
COUNTRY AIRE ESTATES															
System ID Number	County Location														
MO6048048	JEFFERSON	2005	2	P	30	17	0	100	0	0	0	0	0.0430	0.0040	0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
COUNTRY AIRE MHP															
System ID Number	County Location														
MO4048167	TEXAS	1974	1	P	66	22	0	100	0	0	0	0	0.0360	0.0040	0.0010
COUNTRY COVE															
System ID Number	County Location														
MO6048093	WARREN	1970	1	P	52	50	0	100	0	0	0	0	0.0650	0.0150	0.0100
COUNTRY ESTATES															
System ID Number	County Location														
MO6030484	ST CHARLES	1993	C1	P	30	20	0	100	0	0	0	0		0.0020	0.0000
COUNTRY FARM ESTATES HOA INC															
System ID Number	County Location														
MO5031294	TANEY	1999	2	P	183	73	0	100	0	0	0	0	0.0540	0.0050	0.0530
COUNTRY LAKES RV PARK															
System ID Number	County Location														
MO3242566	BENTON	2002	1	P	46	67	0	100	0	0	0	0			0.0000
COUNTRY MEADOWS ESTATES															
System ID Number	County Location														
MO5039093	CHRISTIAN	1990	2	P	120	39	0	100	0	0	0	0			0.0310
COUNTRY SQUIRE VILLAGE															
System ID Number	County Location														
MO5048107	GREENE	1970	1	P	189	60	0	100	0	0	0	0	0.0530	0.0110	0.0020
COUNTRY TIME ESTATES															
System ID Number	County Location														
MO5030870	STONE	1994	2	P	50	28	0	100	0	0	0	0	0.0860		0.0170
COUNTRY VILLAGE ESTATES SUBDIVISION															
System ID Number	County Location														
MO4030275	CAPE GIRARDEAU	1992	1	P	40	17	0	100	0	0	0	0	0.0860		0.0020
CRESTVIEW ACRES SUBD															
System ID Number	County Location														
MO6036074	FRANKLIN	1965	1	P	150	56	0	100	0	0	0	0	0.0400	0.0060	0.0020

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
CRESTVIEW MHP															
System ID Number	County Location														
MO3048254	PETTIS	1960	1	P	72	16	0	100	0	0	0	0		0.0040	0.0000
CROSS CREEK SUBD															
System ID Number	County Location														
MO3031232	CAMDEN	2005	2	P	100	53	0	100	0	0	0	0			0.0170
CROSS ROADS ACRES															
System ID Number	County Location														
MO5036187	GREENE	1990	1	P	65	26	0	100	0	0	0	0		0.0070	0.0000
CROWN MOBILE HOME PARK															
System ID Number	County Location														
MO1041618	CASS	2011	1	P	400	205	0	0	0	100	0	0		0.0250	0.0000
CRYSTAL BEACH SUBD															
System ID Number	County Location														
MO5031192	STONE	2000	1	P	91	49	0	100	0	0	0	0			0.0100
CRYSTAL COVE MHP															
System ID Number	County Location														
MO6048142	JEFFERSON	1971	1	P	40	14	0	100	0	0	0	0	0.0400	0.0060	0.0020
CTW WATERWORKS INC															
System ID Number	County Location														
MO5031513	CHRISTIAN	2011	2	P	80	36	0	100	0	0	0	0			0.0660
DD16 POA															
System ID Number	County Location														
MO5031473	STONE	2005	2	P	39	16	0	100	0	0	0	0			0.0080
DEER MOUNTAIN HEIGHTS															
System ID Number	County Location														
MO5031629	STONE	2013	2	P	27	11	0	100	0	0	0	0			0.0090
DEER RUN APTS															
System ID Number	County Location														
MO5070683	TANEY	1993	2	P	96	36	0	100	0	0	0	0	0.0720	0.0020	0.0050

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
DEER RUN SUBD															
System ID Number	County Location														
MO4036194	CARTER	1970	1	P	500	197	0	0	0	0	100	0		0.0750	0.0000
DEER VALLEY SUBDIVISION															
System ID Number	County Location														
MO6031502	LINCOLN	2011	1	P	25	14	0	100	0	0	0	0	0.0040	0.0010	0.0100
DIANAS BOARDING HOME 2															
System ID Number	County Location														
MO4061392	BOLLINGER	2003	1	P	45	1	0	100	0	0	0	0		0.0020	0.0010
DOCS RETREAT UNIT 1															
System ID Number	County Location														
MO3031321	BENTON	2000	1	P	105	35	0	100	0	0	0	0		0.0070	0.0000
DOOLITTLE MHP															
System ID Number	County Location														
MO3048097	MILLER	1975	1	P	100	40	0	100	0	0	0	0	0.1000	0.0060	0.0050
DOYLE APARTMENTS															
System ID Number	County Location														
MO5071632	MILLER	2015	1	P	32	1	0	100	0	0	0	0			0.0000
EAGLE ESTATES															
System ID Number	County Location														
MO4031203	ST FRANCOIS	2001	1	P	300	105	0	100	0	0	0	0	0.0240	0.0170	0.0050
EAGLE MHP															
System ID Number	County Location														
MO3048243	MILLER	1962	1	P	30	17	0	100	0	0	0	0	0.0400	0.0030	0.0000
EAGLE RIDGE ESTATES															
System ID Number	County Location														
MO5031604	STONE	2009	2	P	25	15	0	100	0	0	0	0			0.0070
EAGLE WOODS SUBDIVISION															
System ID Number	County Location														
MO5030015	CAMDEN	2014	2	P	85	34	0	100	0	0	0	0		0.0040	0.0090

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
EAST WIND COMMUNITY															
System ID Number	County Location														
MO5079504	OZARK	1991	1	P	70	4	0	100	0	0	0	0	0.0570	0.0040	0.0000
EASTBOUROUGH SUBD															
System ID Number	County Location														
MO5036258	GREENE	1973	2	P	144	48	0	100	0	0	0	0	0.0430	0.0070	0.0200
ECHO VALLEY SUBDIVISION															
System ID Number	County Location														
MO3031267	CAMDEN	1998	2	P	175	74	0	100	0	0	0	0			0.0010
EDGEWATER VILLAGE															
System ID Number	County Location														
MO5031235	STONE	2004	1	P	57	51	0	100	0	0	0	0			0.1500
EL KAY LAKE VIEW MOTEL															
System ID Number	County Location														
MO3190694	CAMDEN	1991	1	P	45	27	0	100	0	0	0	0	0.0280		0.0000
ELM HILLS UTILITY OPERATING COMPANY INC															
System ID Number	County Location														
MO3048155	PETTIS	1972	1	P	154	61	0	100	0	0	0	0	0.0500	0.0230	0.0080
ELMO SUBDIVISION 1 & 2 & 3															
System ID Number	County Location														
MO5031088	BARRY	1994	2	P	275	98	0	100	0	0	0	0		0.0350	0.0100
ELSBERRY HEALTH CARE CENTER															
System ID Number	County Location														
MO6069069	LINCOLN	1976	1	P	60	1	0	100	0	0	0	0	0.0300	0.0080	0.0010
EMERALD GREEN ESTATES															
System ID Number	County Location														
MO6030008	LINCOLN	1992	1	P	100	35	0	100	0	0	0	0	0.0070	0.0030	0.0040
EMMAUS HOMES INC															
System ID Number	County Location														
MO6069070	WARREN	1989	2	P	90	20	0	100	0	0	0	0		0.0170	0.0600

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
EVERGREEN LAKE ESTATES															
System ID Number	County Location														
MO6036134	FRANKLIN	1969	1	P	150	53	0	100	0	0	0	0	0.2880	0.0150	0.0500
FAIR HAVEN CHILDRENS HOME															
System ID Number	County Location														
MO5069056	GREENE	1989	1	P	45	12	0	100	0	0	0	0	0.0540	0.0030	0.0020
FAIRWAYS WATER AND SEWER ASSN															
System ID Number	County Location														
MO6036161	JEFFERSON	1987	1	P	150	83	0	100	0	0	0	0	0.0860	0.0070	0.0230
FALL CREEK HEIGHTS SUBD															
System ID Number	County Location														
MO5031149	TANEY	1996	1	P	50	15	0	100	0	0	0	0	0.0860		0.0000
FARMINGTON CORRECTIONAL CENTER															
System ID Number	County Location														
MO4069041	ST FRANCOIS	1989	C2	S	4,000	250	0	100	0	0	0	0	0.1000	0.4040	0.5000
FARMINGTON MANOR															
System ID Number	County Location														
MO4069065	ST FRANCOIS	1987	C1	P	50	1	0	100	0	0	0	0	0.0900	0.0020	0.0000
FARRAR WATER ASSN															
System ID Number	County Location														
MO4030223	PERRY	1991	1	P	42	15	0	100	0	0	0	0			0.0000
FAWN LAKES															
System ID Number	County Location														
MO6031357	LINCOLN	2002	1	P	75	30	0	100	0	0	0	0	0.0010		0.0010
FAWN VALLEY ESTATES															
System ID Number	County Location														
MO3036175	CAMDEN	1991	1	P	150	61	0	100	0	0	0	0		0.0070	0.0250
FERNDALE RESIDENTIAL CARE II															
System ID Number	County Location														
MO3069014	PHELPS	1990	1	P	32	1	0	100	0	0	0	0	0.0150	0.0020	0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
FERRELLS TRAILER COURT															
System ID Number	County Location														
MO4048095	SCOTT	1971	1	P	263	78	0	100	0	0	0	0	0.0570	0.0170	0.0030
FICKEN HILL SUBD															
System ID Number	County Location														
MO6036042	JEFFERSON	1956	1	P	30	13	0	100	0	0	0	0	0.0170	0.0070	0.0000
FINLEY VALLEY/CITY OF OZARK															
System ID Number	County Location														
MO5036273	CHRISTIAN	1985	2	L	560	221	0	100	0	0	0	0	0.1640	0.0210	0.0580
FOREST GLEN/QUAIL RIDGE SUBD															
System ID Number	County Location														
MO5031353	STONE	2001	2	P	100	45	0	100	0	0	0	0		0.0170	0.0200
FOREST PARK/DEER PARK															
System ID Number	County Location														
MO5036100	STONE	1990	2	P	150	81	0	100	0	0	0	0	0.1080		0.0200
FOREST RIDGE SUBDIVISION															
System ID Number	County Location														
MO5031434	CAMDEN	2014	2	P	30	16	0	100	0	0	0	0		0.0020	0.0450
FORT LEONARD WOOD															
System ID Number	County Location														
MO3079500	PULASKI	1941	A3	F	34,000	2,294	97	3	0	0	0	0	6.0000	2.8000	4.2510
FOUNTAIN PLAZA MHP															
System ID Number	County Location														
MO5048281	WEBSTER	1991	2	P	165	51	0	100	0	0	0	0		0.0060	0.0040
FOX WOODS SUBDIVISION															
System ID Number	County Location														
MO5036197	BARRY	1991	2	P	125	41	0	100	0	0	0	0	0.0790	0.0040	0.0110
FOXBORO SUBDIVISION															
System ID Number	County Location														
MO6036323	FRANKLIN	1991	1	P	30	18	0	100	0	0	0	0	0.0020	0.0020	0.0020

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
FOXHEAD SHORES															
System ID Number	County Location														
MO3036078	CAMDEN	1991	2	P	134	50	0	100	0	0	0	0	0.8000	0.0150	0.0070
FRANKLIN COUNTY PWSD 1 CARDINAL MEADOWS															
System ID Number	County Location														
MO6031215	FRANKLIN	2001	2	P	52	21	0	100	0	0	0	0	0.0360	0.0050	0.0100
FRANKLIN COUNTY PWSD 3 LAKE SERENE															
System ID Number	County Location														
MO6036075	FRANKLIN	1957	1	L	600	180	0	100	0	0	0	0	0.0850	0.0350	0.1500
FRANKLIN COUNTY WATER COMPANY INC															
System ID Number	County Location														
MO6036009	FRANKLIN	1969	1	P	186	191	0	100	0	0	0	0	0.0600	0.0290	0.0450
FRIENDSHIP HILLS SUBD															
System ID Number	County Location														
MO5031165	CEDAR	1996	2	P	35	25	0	100	0	0	0	0		0.0040	0.0100
FRONTIER ESTATES															
System ID Number	County Location														
MO6036101	JEFFERSON	1963	1	P	135	47	0	100	0	0	0	0	0.0360	0.0280	0.0200
FUGATE MOBILE HOME PARK															
System ID Number	County Location														
MO5238302	HICKORY	1991	1	P	100	67	0	100	0	0	0	0			0.0000
GASCONADE PWSD #1															
System ID Number	County Location														
MO6036015	GASCONADE	1966	1	P	200	190	0	100	0	0	0	0	0.2800	0.0400	0.0880
GASCONY VILLAGE															
System ID Number	County Location														
MO3031293	GASCONADE	1999	1	P	170	177	0	100	0	0	0	0		0.0020	0.0020

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
GENERAL COUNCIL ASSEMBLIES OF GOD															
System ID Number	County Location														
MO5069088	GREENE	1979	1	P	750	46	0	100	0	0	0	0	0.3530	0.0560	0.0000
GLADLO WATER & SEWER INC															
System ID Number	County Location														
MO3036151	PHELPS	1962	1	P	150	71	0	100	0	0	0	0	0.0750	0.0070	0.0010
GLEN MEADOWS															
System ID Number	County Location														
MO6031360	LINCOLN	2004	1	P	500	210	0	100	0	0	0	0			0.0340
GLEN OAKS SUBD															
System ID Number	County Location														
MO5252173	STONE	1989	2	P	29	28	0	100	0	0	0	0	0.0380	0.0040	0.0070
GLENBROOK ESTATES															
System ID Number	County Location														
MO6036096	WARREN	1991	1	P	100	48	0	100	0	0	0	0	0.0090	0.0010	0.0040
GOBBLERS KNOB MOBILE HOME PARK															
System ID Number	County Location														
MO5048286	TANEY	1971	2	P	230	92	0	100	0	0	0	0			0.0150
GOBBLERS MOUNTAIN/PARKVIEW WATER ASSOCIA															
System ID Number	County Location														
MO5036170	STONE	1960	1	P	250	100	0	100	0	0	0	0		0.0180	0.0270
GOLD RIDGE NORTH															
System ID Number	County Location														
MO5033098	CHRISTIAN	2013	1	P	28	10	0	100	0	0	0	0			0.0000
GOLDEN GLADE WATER SYSTEM															
System ID Number	County Location														
MO3031299	CAMDEN	2002	1	P	50	21	0	100	0	0	0	0		0.0030	0.0000
GOLDEN OAK VILLAGE SUBD															
System ID Number	County Location														
MO5031325	GREENE	2008	2	P	50	24	0	100	0	0	0	0		0.0060	0.0150

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
GOOD SAMARITAN BOYS RANCH															
System ID Number	County Location														
MO5238119	POLK	1991	1	P	87	14	0	100	0	0	0	0	0.0490	0.0060	0.0020
GRANDVIEW PLAZA MHP															
System ID Number	County Location														
MO6048248	WASHINGTON	1989	2	P	110	41	0	100	0	0	0	0	0.0050	0.0020	0.0020
GRAYHAWK WATER															
System ID Number	County Location														
MO4010701	STE GENEVIEVE	1965	2	P	450	314	0	100	0	0	0	0	0.1300	0.0740	0.2100
GREAT CIRCLE															
System ID Number	County Location														
MO3069013	PHELPS	1956	2	P	200	24	0	100	0	0	0	0	0.1600	0.0120	0.0000
GREEN ACRES HOMEOWNERS ASSOCIATION															
System ID Number	County Location														
MO5031621	TANEY	2011	1	P	45	18	0	100	0	0	0	0		0.0020	0.0000
GREEN ACRES MOBILE HOME PARK															
System ID Number	County Location														
MO5031533	CAMDEN	2006	1	P	25	9	0	100	0	0	0	0			0.0000
GREEN HILLS MHP															
System ID Number	County Location														
MO3048033	BOONE	2008	1	P	240	76	0	0	0	0	100	0			0.0000
GREEN SHORES SUBD															
System ID Number	County Location														
MO5036102	BARRY	1960	2	P	120	63	0	100	0	0	0	0	0.3240	0.0150	0.0420
GREEN WOODS															
System ID Number	County Location														
MO5251518	BARRY	2006	2	P	25	21	0	100	0	0	0	0		0.0030	0.0100
GREENE HILLS WATER ASSN															
System ID Number	County Location														
MO5031115	GREENE	1997	2	P	93	31	0	100	0	0	0	0	0.1680	0.0060	0.0210

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
GREENWOOD VALLEY															
System ID Number	County Location														
MO6031389	FRANKLIN	2003	2	P	60	21	0	100	0	0	0	0			0.0000
HATTON HILLS MHP															
System ID Number	County Location														
MO3041238	CALLAWAY	2006	1	P	70	23	0	100	0	0	0	0		0.0150	0.0370
HAWK ISLAND ESTATES															
System ID Number	County Location														
MO3036354	CAMDEN	1991	2	P	150	55	0	100	0	0	0	0	0.1000	0.0200	0.0010
HAWKS NEST CONDO ASSN															
System ID Number	County Location														
MO3191837	CAMDEN	1979	1	P	35	65	0	100	0	0	0	0	0.1220		0.0360
HAYFIELD WATER WORKS															
System ID Number	County Location														
MO6031237	FRANKLIN	1999	2	P	45	10	0	100	0	0	0	0		0.0000	0.0350
HEIM MHP															
System ID Number	County Location														
MO5048177	LAWRENCE	1956	2	P	112	36	0	100	0	0	0	0	0.0100	0.0070	0.0100
HENRYS MOBILE HOME PARK															
System ID Number	County Location														
MO4048241	HOWELL	1992	1	P	80	39	0	100	0	0	0	0	0.0500	0.0040	0.0000
HERMIT HOLLOW SUBD															
System ID Number	County Location														
MO6036139	FRANKLIN	1990	1	P	30	16	0	100	0	0	0	0		0.0020	0.0000
HIDDEN HILLS ESTATES															
System ID Number	County Location														
MO3036234	PETTIS	1995	1	P	60	27	0	100	0	0	0	0	0.0300	0.0100	0.0050
HIDDEN OAKS ESTATES															
System ID Number	County Location														
MO3031207	CAMDEN	1997	C1	P	50	31	0	100	0	0	0	0	0.1800	0.0050	0.0040

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
HIDDEN RIDGE ESTATES MHP															
System ID Number	County Location														
MO5041129	TANEY	1995	2	P	240	96	0	100	0	0	0	0	0.1000	0.0180	0.0250
HIDDEN SHORES SUBD															
System ID Number	County Location														
MO5031153	STONE	1995	2	P	100	55	0	100	0	0	0	0	0.1190		0.0400
HIDDEN VALLEY FISHING CLUB															
System ID Number	County Location														
MO4202639	CAPE GIRARDEAU	2004	1	P	70	132	0	100	0	0	0	0		0.0110	0.0010
HIDDEN VALLEY MHP															
System ID Number	County Location														
MO3262156	BENTON	1992	1	P	60	34	0	100	0	0	0	0	0.0860	0.0030	0.0000
HIDEAWAY MHP															
System ID Number	County Location														
MO5041419	TANEY	2004	2	P	35	18	0	100	0	0	0	0	0.0430	0.0020	0.0030
HIGH POINT ESTATES															
System ID Number	County Location														
MO3036122	PULASKI	1990	1	P	200	61	0	100	0	0	0	0	0.0700	0.0100	0.0110
HIGH RIDGE MANOR SUBD															
System ID Number	County Location														
MO6036060	JEFFERSON	1963	1	P	175	86	0	100	0	0	0	0	0.5800	0.0100	0.0030
HIGHLAND MANOR															
System ID Number	County Location														
MO1041289	JACKSON	1999	1	P	957	307	0	0	0	0	100	0		0.0400	0.0000
HIGHLANDS SEWER & WATER ASSN INC															
System ID Number	County Location														
MO5030690	TANEY	1994	2	P	342	137	0	100	0	0	0	0	0.2370	0.0310	0.0430
HILLCREST UTILITY OPERATING COMPANY INC															
System ID Number	County Location														
MO4036038	CAPE GIRARDEAU	1975	1	P	500	236	0	100	0	0	0	0	0.1440	0.0400	0.0600

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
HILLSHINE ACRES SUBD															
System ID Number	County Location														
MO6036135	FRANKLIN	1970	1	P	80	33	0	100	0	0	0	0	0.2160	0.0040	0.0000
HILLTOP WATER CORP															
System ID Number	County Location														
MO5036236	STONE	1991	2	P	40	25	0	100	0	0	0	0	0.0170	0.0040	0.0150
HOLIDAY HILLS 1 2 3 ADDITION															
System ID Number	County Location														
MO5036017	STONE	1959	2	P	80	55	0	100	0	0	0	0	0.0890	0.0050	0.0110
HOLIDAY HILLS RESORT															
System ID Number	County Location														
MO5190947	TANEY	1984	2	P	2,065	481	0	100	0	0	0	0	1.4970	0.2000	0.2250
HOLTGREWE FARMS SUBDIVISION															
System ID Number	County Location														
MO6031607	FRANKLIN	2017	1	P	25	25	0	100	0	0	0	0	0.0420	0.0000	0.0110
HOMETOWN COURT															
System ID Number	County Location														
MO6041286	LINCOLN	1999	1	P	152	64	0	100	0	0	0	0	0.1080	0.0100	0.0060
HOOT OWL POINT SUBD															
System ID Number	County Location														
MO5036076	STONE	1971	2	P	120	76	0	100	0	0	0	0	0.0570	0.0100	0.0000
HORIZON MHP															
System ID Number	County Location														
MO5048047	STONE	1991	2	P	68	24	0	100	0	0	0	0		0.0030	0.0060
HORIZON WEST SUBDIVISION															
System ID Number	County Location														
MO5031284	STONE	2015	2	P	63	24	0	100	0	0	0	0			0.0220
HORSE SHOE BEND															
System ID Number	County Location														
MO6048163	FRANKLIN	1971	1	P	70	31	0	100	0	0	0	0	0.0390	0.0050	0.0100

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
HOWARD COUNTY REGIONAL WATER COMM															
System ID Number	County Location														
MO2021598	HOWARD	2017	B2	L	25	3	0	100	0	0	0	0			0.5000
HUNTERS GLEN															
System ID Number	County Location														
MO6031362	JEFFERSON	2005	2	L	240	119	0	100	0	0	0	0	0.0250	0.0250	0.2360
HUNTERS RIDGE SUBD															
System ID Number	County Location														
MO4031206	ST FRANCOIS	2001	C1	P	468	147	0	100	0	0	0	0	0.1080	0.1080	0.0630
HWY 43 MOBILE HOME & RV PARK															
System ID Number	County Location														
MO5048974	NEWTON	1991	2	P	137	67	0	100	0	0	0	0	0.0320	0.0150	0.0160
I 70 MOBILE CITY MHP															
System ID Number	County Location														
MO1041187	LAFAYETTE	1997	2	P	173	71	0	0	0	0	100	0		0.0100	0.0000
INDIAN HILLS HOMEOWNERS ASSN															
System ID Number	County Location														
MO5036272	STONE	1961	2	P	100	54	0	100	0	0	0	0			0.0200
INDIAN HILLS UTILITIES OPERATING COMPANY															
System ID Number	County Location														
MO6036052	CRAWFORD	1963	2	P	2,200	715	0	100	0	0	0	0	0.8600	0.1010	0.3410
INNSBROOK															
System ID Number	County Location														
MO6036142	WARREN	1981	D2	P	810	759	0	100	0	0	0	0	0.1230	0.2870	0.1300
IRIS ROAD LLC															
System ID Number	County Location														
MO5041190	NEWTON	1996	1	P	35	24	0	100	0	0	0	0			0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
ISLA DEL SOL															
System ID Number	County Location														
MO5301479	MILLER	2008	2	P	25	90	0	100	0	0	0	0			0.1160
J BAR H ESTATES															
System ID Number	County Location														
MO5031601	CAMDEN	2009	1	P	40	18	0	100	0	0	0	0			0.0000
JAMES RIVER ADDITION															
System ID Number	County Location														
MO5036115	GREENE	1970	1	P	240	96	0	100	0	0	0	0	0.0800	0.0170	0.0100
JAMES RIVER ESTATES SUBD															
System ID Number	County Location														
MO5031315	CHRISTIAN	2002	2	P	50	23	0	100	0	0	0	0	0.0860	0.0860	0.0300
JEFF COUNTY REHAB PARTNERS LP															
System ID Number	County Location														
MO6079508	JEFFERSON	1981	1	P	48	4	0	100	0	0	0	0	0.1720	0.0030	0.0010
JEFFERSON COUNTY WATER AUTHORITY															
System ID Number	County Location														
MO6071352	JEFFERSON	2003	A	L	25	3	0	0	100	0	0	0		1.6000	0.4000
JOHNS BRANCH WATER CO															
System ID Number	County Location														
MO4036309	WAYNE	1976	1	P	78	26	0	100	0	0	0	0			0.0040
JOHNSON BAY SUBDIVISION															
System ID Number	County Location														
MO3031338	MORGAN	2002	2	P	133	53	0	100	0	0	0	0	0.0210	0.0130	0.0170
JOYCE RENTALS															
System ID Number	County Location														
MO5071459	WEBSTER	2005	1	P	66	22	0	100	0	0	0	0		0.0240	0.0000
KEITHLEY BEACH SUBD															
System ID Number	County Location														
MO3036166	BENTON	1953	1	P	240	92	0	100	0	0	0	0	0.0400	0.0200	0.0080

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
KILLARNEY SHORES SUBD															
System ID Number	County Location														
MO4036256	IRON	1964	C2	P	200	90	0	100	0	0	0	0	0.0250	0.0080	0.0300
KIMBERLING AIRWAYS SUBD															
System ID Number	County Location														
MO5036356	STONE	1991	2	P	75	94	0	100	0	0	0	0		0.0100	0.0330
KINGS RIVER BEACH WATER ASSOCIATION INC															
System ID Number	County Location														
MO5031309	BARRY	1999	2	P	50	52	0	100	0	0	0	0		0.0050	0.0210
KK WATER SUPPLY															
System ID Number	County Location														
MO3036050	CAMDEN	1967	2	P	2,500	1,200	0	100	0	0	0	0	1.8000	0.3500	0.1000
KNOB HILL ACRES															
System ID Number	County Location														
MO5036182	BARRY	1972	2	P	125	60	0	100	0	0	0	0	0.0180	0.0010	0.0180
KUHLE H20															
System ID Number	County Location														
MO3036153	BOONE	1988	1	P	450	100	0	100	0	0	0	0	0.1150	0.0260	0.0410
LAKE ADELLE SUBD															
System ID Number	County Location														
MO6036077	JEFFERSON	1949	2	P	390	150	0	100	0	0	0	0	0.0820	0.0390	0.1040
LAKE COUNTRY VILLAGE POA															
System ID Number	County Location														
MO5030178	STONE	1992	1	P	80	46	0	100	0	0	0	0		0.0110	0.0000
LAKE FOREST ESTATES															
System ID Number	County Location														
MO4036146	STE GENEVIEVE	1970	2	P	850	286	0	100	0	0	0	0	0.3310	0.0640	0.1500

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
LAKE FOREST SUBDIVISION															
System ID Number	County Location														
MO5036203	HICKORY	1973	2	P	200	117	0	100	0	0	0	0		0.0030	0.0010
MO6031418	LINCOLN	2004	1	P	35	32	0	100	0	0	0	0	0.4320		0.0050
LAKE HILLS PARK															
System ID Number	County Location														
MO3040761	BENTON	1993	1	P	40	30	0	100	0	0	0	0			0.0000
LAKE KAH TAN DA ESTATES INC															
System ID Number	County Location														
MO4036202	PERRY	1970	1	P	277	115	0	100	0	0	0	0	0.0570	0.0080	0.0050
LAKE LORRAINE WATER CO															
System ID Number	County Location														
MO6036028	JEFFERSON	1962	1	P	230	105	0	100	0	0	0	0	0.0650	0.0060	0.0340
LAKE MEADOWS MHP															
System ID Number	County Location														
MO5048754	POLK	1988	2	P	100	68	0	100	0	0	0	0	0.0240	0.0120	0.0160
LAKE NORTHWOODS UTILITY INC															
System ID Number	County Location														
MO3031317	GASCONADE	2000	1	P	27	20	0	100	0	0	0	0	0.4320	0.0020	0.0240
LAKE RIDGE BAY															
System ID Number	County Location														
MO3031364	BENTON	2007	1	P	120	48	0	100	0	0	0	0	0.0020		0.0000
LAKE SEVEN FALLS ASSN INC															
System ID Number	County Location														
MO4256181	STE GENEVIEVE	1976	2	P	188	76	0	100	0	0	0	0	0.0430	0.0210	0.0100
LAKE SHERWOOD SUBD															
System ID Number	County Location														
MO6036039	WARREN	1968	2	P	1,100	484	0	100	0	0	0	0	0.3310	0.0730	0.2580

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
LAKE TANEYCOMO WOODS															
System ID Number	County Location														
MO5036012	TANEY	1972	2	P	110	47	0	100	0	0	0	0	0.1720	0.0060	0.0640
LAKE THUNDERHEAD															
System ID Number	County Location														
MO2036165	PUTNAM	1969	1	P	400	585	0	0	0	100	0	0		0.0210	0.0000
LAKEHURST MHP															
System ID Number	County Location														
MO6048040	JEFFERSON	1984	1	P	100	42	0	100	0	0	0	0	0.0120	0.0100	0.0000
LAKELAND HEIGHTS WATER CO															
System ID Number	County Location														
MO4036069	BUTLER	1968	1	P	303	111	0	100	0	0	0	0	0.0790	0.0090	0.0030
LAKESIDE AT CROSS CREEK															
System ID Number	County Location														
MO5031496	CAMDEN	2016	2	P	50	20	0	100	0	0	0	0	0.0960	0.0030	0.0270
LAKESIDE COMMUNITY INC															
System ID Number	County Location														
MO3031118	PHELPS	1997	1	P	200	81	0	100	0	0	0	0	0.3000	0.0100	0.0050
LAKESIDE ESTATES SUBD															
System ID Number	County Location														
MO3036155	PHELPS	1971	1	P	77	35	0	100	0	0	0	0	0.0250	0.0060	0.0020
LAKESIDE MANOR															
System ID Number	County Location														
MO6048073	JEFFERSON	2006	1	P	150	58	0	100	0	0	0	0	0.0700	0.0170	0.0040
LAKESIDE MOUNTAIN MANOR															
System ID Number	County Location														
MO5069068	TANEY	1975	1	P	55	1	0	100	0	0	0	0		0.0030	0.0000
LAKEVIEW SUBD BLOCK C															
System ID Number	County Location														
MO5036268	TANEY	1973	2	P	25	34	0	100	0	0	0	0	0.0250	0.0070	0.0080

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
LAKEWOOD HEIGHTS SUBD															
System ID Number	County Location														
MO3036099	PETTIS	1958	1	P	40	26	0	100	0	0	0	0	0.1000	0.0030	0.0000
LAKEWOOD HILLS SUBD															
System ID Number	County Location														
MO6036049	JEFFERSON	1964	1	P	400	114	0	100	0	0	0	0	0.1720	0.0200	0.0180
LANTERN BAY RESORT CONDO															
System ID Number	County Location														
MO5071085	STONE	1994	D2	P	450	251	0	100	0	0	0	0	0.3450	0.0330	0.0890
LAUREL ACRES MHP															
System ID Number	County Location														
MO6048147	JEFFERSON	1971	1	P	124	45	0	100	0	0	0	0	0.0400	0.0090	0.0300
LEAD M THE OAKS															
System ID Number	County Location														
MO4041636	CRAWFORD	2016	1	P	72	24	0	100	0	0	0	0			0.0000
LEISURE SHORES UNIT 2															
System ID Number	County Location														
MO5036145	STONE	1991	2	P	50	28	0	100	0	0	0	0	0.3160		0.0100
LEONARDS MOBILE HOME PARK															
System ID Number	County Location														
MO6048100	JEFFERSON	1985	1	P	40	22	0	100	0	0	0	0	0.0910	0.0150	0.0060
LIFE STYLE MHP															
System ID Number	County Location														
MO6048150	JEFFERSON	1970	1	P	321	77	0	100	0	0	0	0	0.0700	0.0370	0.0050
LINN ACRES															
System ID Number	County Location														
MO2041594	OSAGE	2008	1	P	75	21	0	100	0	0	0	0			0.0000
LONGVIEW SUBDIVISION															
System ID Number	County Location														
MO5036016	STONE	1990	2	P	95	47	0	100	0	0	0	0	0.0280	0.0080	0.0340

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
LOOKOUT POINT SUBD															
System ID Number	County Location														
MO3036018	MILLER	1947	2	P	80	36	0	100	0	0	0	0	0.0350	0.0080	0.0120
LOST CREEK WATER COMPANY															
System ID Number	County Location														
MO4036306	WAYNE	1976	1	P	208	52	0	100	0	0	0	0		0.0170	0.0060
LUCKY LADY MOBILE HOME PARK															
System ID Number	County Location														
MO5048294	LAWRENCE	2006	1	P	46	16	0	100	0	0	0	0	0.1000	0.0030	0.0000
M & M MOBILE HOME PARK															
System ID Number	County Location														
MO1041228	JOHNSON	1997	1	P	100	35	0	100	0	0	0	0	0.0270		0.0090
MACKENZIE RIDGE LLC															
System ID Number	County Location														
MO6048148	JEFFERSON	1971	C1	P	180	66	0	100	0	0	0	0		0.0160	0.0080
MAJESTIC LAKES															
System ID Number	County Location														
MO6031412	LINCOLN	2006	1	P	143	60	0	100	0	0	0	0		0.0200	0.4200
MAKALU ESTATES															
System ID Number	County Location														
MO3031208	CAMDEN	1997	2	P	75	32	0	100	0	0	0	0	0.0430		0.0030
MALFUNCTION JUNCTION															
System ID Number	County Location														
MO5031602	JASPER	2009	1	P	37	20	0	100	0	0	0	0		0.0030	0.0000
MANDERLY MHP															
System ID Number	County Location														
MO6048616	JEFFERSON	1990	2	P	220	87	0	100	0	0	0	0	0.1400	0.0150	0.0180
MAPLE HILL PARK															
System ID Number	County Location														
MO6048153	FRANKLIN	1990	1	P	25	17	0	100	0	0	0	0			0.0000

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Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MAPLE RIDGE MHP															
System ID Number	County Location														
MO6048138	WARREN	1986	2	P	140	60	0	100	0	0	0	0	0.0360	0.0080	0.0200
MC COUCH DRIVE HOA															
System ID Number	County Location														
MO4031626	PULASKI	2012	1	P	50	18	0	100	0	0	0	0			0.0000
MEADOW DRIVE SUBD															
System ID Number	County Location														
MO6036081	JEFFERSON	1955	1	P	60	17	0	100	0	0	0	0	0.0200	0.0210	0.0000
MEADOW HILLS SUBDIVISION															
System ID Number	County Location														
MO5031142	STONE	1996	2	P	25	20	0	100	0	0	0	0			0.0070
MEADOW RIDGE SUBDIVISION															
System ID Number	County Location														
MO5030915	TANEY	1994	2	P	710	285	0	100	0	0	0	0	0.4000	0.0960	0.1020
MEADOWLARK ACRES MHP															
System ID Number	County Location														
MO3048289	PETTIS	1974	1	P	35	25	0	100	0	0	0	0	0.0100	0.0000	0.0040
MEADOWOOD ESTATES SUBD															
System ID Number	County Location														
MO5031126	TANEY	1995	1	P	50	20	0	100	0	0	0	0	0.0400	0.0020	0.0010
MELODY LAKE WATER & SEWER															
System ID Number	County Location														
MO6036041	FRANKLIN	1965	1	P	90	77	0	100	0	0	0	0	0.0750	0.0050	0.0500
MELODY MANOR SUBDIVISION															
System ID Number	County Location														
MO5031145	STONE	1995	2	P	71	27	0	100	0	0	0	0	0.0240		0.0000
MERITTS CAMPGROUND															
System ID Number	County Location														
MO5041253	DALLAS	1998	1	P	30	22	0	100	0	0	0	0		0.0030	0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MID AMERICA TEEN CHALLENGE															
System ID Number	County Location														
MO4079503	CAPE GIRARDEAU	1970	1	P	250	8	0	100	0	0	0	0		0.0110	0.0200
MIDDLE FORK WATER CO															
System ID Number	County Location														
MO1070639	GENTRY	1993	B	P	25	2	100	0	0	0	0	0	1.0000	0.3050	0.3750
MIDLAND WATER CO															
System ID Number	County Location														
MO5040176	CHRISTIAN	1992	2	P	285	93	0	100	0	0	0	0	0.0830	0.0200	0.0100
MILL CREEK SHORES SUBD															
System ID Number	County Location														
MO5031254	STONE	1998	2	P	46	24	0	100	0	0	0	0		0.0080	0.0200
MILLER COUNTY CARE CENTER															
System ID Number	County Location														
MO3069010	MILLER	1991	2	L	180	1	0	100	0	0	0	0	0.0300	0.0050	0.0020
MILLSTONE LUXURY CONDOMINIUMS															
System ID Number	County Location														
MO5301457	MORGAN	2010	1	P	250	104	0	100	0	0	0	0	0.2760	0.0050	0.0680
MILLWOOD ESTATES PROP OWNERS ASSN															
System ID Number	County Location														
MO5031278	STONE	1999	2	P	96	35	0	100	0	0	0	0	0.0860		0.0150
MINNOWBROOK ESTATES															
System ID Number	County Location														
MO3030981	CAMDEN	1994	1	P	75	33	0	100	0	0	0	0	0.0900		0.0120
MIRAMIGUOA PARK															
System ID Number	County Location														
MO6036128	FRANKLIN	1961	1	L	120	60	0	100	0	0	0	0	0.0500	0.0040	0.0370
MIRASOL SUBDIVISION															
System ID Number	County Location														
MO6031523	JEFFERSON	2008	2	P	1,287	350	0	100	0	0	0	0	0.5500	0.0560	0.0550

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MISSIONARY ACRES															
System ID Number	County Location														
MO4036040	WAYNE	1966	1	P	40	28	0	100	0	0	0	0	0.0720	0.0040	0.0050
MISSOURI REHABILITATION CENTER															
System ID Number	County Location														
MO5069029	LAWRENCE	1990	2	S	204	3	0	100	0	0	0	0	1.9220	0.0700	0.3500
MO AMERICAN ANNA MEADOWS															
System ID Number	County Location														
MO6031475	LINCOLN	2012	1	P	225	119	0	100	0	0	0	0	0.0590	0.0350	0.2250
MO AMERICAN EMERALD POINTE SUBD															
System ID Number	County Location														
MO5031148	TANEY	1995	2	P	200	410	0	100	0	0	0	0	0.4460	0.1400	0.1750
MO AMERICAN HICKORY HILLS															
System ID Number	County Location														
MO3036043	MONITEAU	1985	1	P	125	11	0	100	0	0	0	0	0.0060	0.0120	0.0000
MO AMERICAN JAXSON															
System ID Number	County Location														
MO6031461	ST CHARLES	2008	1	P	204	35	0	100	0	0	0	0	1.1000	0.0030	0.0580
MO AMERICAN LAKE CARMEL															
System ID Number	County Location														
MO3031183	COLE	1996	D2	P	123	48	0	100	0	0	0	0	0.0890	0.0110	0.0380
MO AMERICAN LAKE TANEYCOMO ACRES SUBD															
System ID Number	County Location														
MO5036198	TANEY	1989	2	P	280	113	0	100	0	0	0	0	0.1690	0.0300	0.0370
MO AMERICAN LAKEWOOD MANOR SUBD															
System ID Number	County Location														
MO5036020	BARRY	1970	2	P	50	35	0	100	0	0	0	0	0.1150	0.0060	0.0120

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MO AMERICAN MAPLEWOOD SUBDIVISION															
System ID Number	County Location														
MO3036131	PETTIS	1971	2	P	1,000	577	0	100	0	0	0	0	0.1200	0.0900	0.0850
MO AMERICAN OZARK MTN WATER COMPANY 1															
System ID Number	County Location														
MO5036177	BARRY	1989	2	P	350	131	0	100	0	0	0	0	0.2160	0.0230	0.0370
MO AMERICAN OZARK MTN WATER COMPANY 3															
System ID Number	County Location														
MO5036162	STONE	1992	1	P	136	65	0	100	0	0	0	0	0.2160	0.0070	0.0380
MO AMERICAN OZARK MTN WATER COMPANY 2															
System ID Number	County Location														
MO5036163	STONE	1972	1	P	372	191	0	100	0	0	0	0	0.2160	0.0400	0.0580
MO AMERICAN RANKIN ACRES SUBD															
System ID Number	County Location														
MO5036147	GREENE	1965	1	P	215	86	0	100	0	0	0	0	0.1220	0.0180	0.0170
MO AMERICAN RED FIELD SUBDIVISION															
System ID Number	County Location														
MO3031301	COLE	2001	2	P	60	14	0	100	0	0	0	0	0.0500	0.0170	0.0440
MO AMERICAN RIVERSIDE ESTATES															
System ID Number	County Location														
MO5036210	TANEY	1977	C2	P	742	300	0	100	0	0	0	0	0.3600	0.0750	0.1000
MO AMERICAN SADDLEBROOKE VILLAGE OF															
System ID Number	County Location														
MO5031375	CHRISTIAN	2003	2	P	250	96	0	100	0	0	0	0			0.2500
MO AMERICAN SPRING VALLEY ESTATES SUB															
System ID Number	County Location														
MO5036248	CHRISTIAN	1990	1	P	300	95	0	0	0	0	100	0		0.0150	0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MO AMERICAN STONEBRIDGE VILLAGE															
System ID Number	County Location														
MO5031086	STONE	1994	2	P	1,875	783	0	100	0	0	0	0	0.5610	0.3000	0.6500
MO AMERICAN WARREN COUNT WATER & SEWER															
System ID Number	County Location														
MO6036149	WARREN	1991	2	P	1,200	450	0	100	0	0	0	0	0.5800	0.0900	0.4000
MO AMERICAN WHITEBRANCH SUBD															
System ID Number	County Location														
MO3036113	BENTON	1969	2	P	450	136	0	100	0	0	0	0	0.2500	0.0400	0.0840
MO AMERICAN WOODLAND MANOR															
System ID Number	County Location														
MO5036111	STONE	1989	2	P	335	164	0	100	0	0	0	0	0.0700	0.0270	0.0110
MO EASTERN CORRECTIONAL CENTER															
System ID Number	County Location														
MO6069017	ST LOUIS	1981	C2	S	1,100	17	0	100	0	0	0	0	0.4700	0.1500	0.6000
MO PARK CAMPGROUND															
System ID Number	County Location														
MO5048174	WRIGHT	1989	2	P	85	80	0	100	0	0	0	0		0.0030	0.0000
MONSEES LAKE ESTATES															
System ID Number	County Location														
MO3036105	PETTIS	1968	2	P	160	62	0	100	0	0	0	0	0.0090	0.0070	0.0010
MOORE BEND WATER UTILITY LLC															
System ID Number	County Location														
MO5036117	TANEY	1961	2	P	28	73	0	100	0	0	0	0	0.0600	0.0180	0.0010
MORGAN COUNTY PWSD # 2															
System ID Number	County Location														
MO3031358	MORGAN	2002	2	L	1,200	471	0	100	0	0	0	0			0.0130
MORNINGSIDE CHURCH RETREAT															
System ID Number	County Location														
MO5031511	STONE	2008	2	P	300	180	0	100	0	0	0	0			0.3000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
MOUNTAIN ESTATES															
System ID Number	County Location														
MO5036125	STONE	1974	2	P	76	39	0	100	0	0	0	0	0.1290	0.0060	0.0150
NEW CHRISTIAN LIFE FELLOWSHIP															
System ID Number	County Location														
MO3048994	CALLAWAY	1979	1	P	45	14	0	90	0	0	10	0	0.0400	0.0040	0.0120
NEW HAMBURG CENTRAL															
System ID Number	County Location														
MO4031614	SCOTT	2010	1	P	45	18	0	100	0	0	0	0			0.0000
NEW HAMBURG SOUTH END															
System ID Number	County Location														
MO4031611	SCOTT	2010	1	P	60	24	0	100	0	0	0	0			0.0000
NEW TRIBES MISSION INC															
System ID Number	County Location														
MO3281045	CAMDEN	1994	2	P	375	51	0	100	0	0	0	0			0.0680
NORTH CENTRAL MO REGIONAL WATER COM															
System ID Number	County Location														
MO2021537	SULLIVAN	2006	A2	L	25	3	100	0	0	0	0	0	2.8000	0.6520	0.0000
NORTH HILLS ESTATES															
System ID Number	County Location														
MO4036144	CAPE GIRARDEAU	1972	1	P	100	40	0	100	0	0	0	0		0.0220	0.0350
NORTHERN HEIGHTS ESTATES SUBDIVISION															
System ID Number	County Location														
MO4031414	PULASKI	2007	1	P	961	262	0	100	0	0	0	0		0.1590	0.0110
OAK CREEK PARKWAY SUBD															
System ID Number	County Location														
MO5031194	STONE	1997	2	P	240	81	0	100	0	0	0	0	0.0430	0.0020	0.0400

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
OAK CREST ESTATES MOBILE HOME SUBD															
System ID Number	County Location														
MO5048194	GREENE	1991	2	P	105	33	0	100	0	0	0	0	0.0570	0.0310	0.0100
OAK GROVE TRAILER PARK															
System ID Number	County Location														
MO5048178	TANEY	1990	1	P	40	25	0	100	0	0	0	0	0.0280	0.0010	0.0000
OAK HILL FOREST SUBDIVISION															
System ID Number	County Location														
MO3031381	MILLER	2011	1	P	25	12	0	100	0	0	0	0	0.0000	0.0030	0.0580
OAK HILL MHP															
System ID Number	County Location														
MO5048211	WEBSTER	1974	2	P	46	50	0	100	0	0	0	0	0.0440	0.0090	0.0130
OAK RIDGE ACRES															
System ID Number	County Location														
MO1031536	BENTON	2007	1	P	120	49	0	100	0	0	0	0	0.0090		0.0090
OAK RIDGE ESTATES															
System ID Number	County Location														
MO5041266	WEBSTER	1998	1	P	25	21	0	100	0	0	0	0			0.0000
OAK SHADOWS SUBDIVISION															
System ID Number	County Location														
MO5031544	CAMDEN	2007	1	P	36	12	0	100	0	0	0	0			0.0000
OAK SHADOWS WATER ASSN															
System ID Number	County Location														
MO5036250	STONE	1967	2	P	75	45	0	100	0	0	0	0	0.1080	0.0050	0.0250
OAKBRIER ESTATES															
System ID Number	County Location														
MO4036026	BUTLER	1976	1	P	100	60	0	100	0	0	0	0	0.0430	0.0110	0.0000
OAKS HOMEOWNERS ASSN WATER DIST															
System ID Number	County Location														
MO5036300	BARRY	1993	1	P	85	34	0	100	0	0	0	0	0.0370	0.0060	0.0080

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name	System ID Number	County Location	Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
OAKWOOD HOMEOWNERS ASSN	MO5031526	STONE	2006	2	P	80	36	0	100	0	0	0	0			0.0060
OAKWOOD WATER ASSN	MO1031542	HENRY	2007	1	P	28	16	0	100	0	0	0	0			0.0000
OCWC SPRING BRANCH WATER	MO3031322	BENTON	2000	2	P	480	102	0	100	0	0	0	0			0.0030
OLD KINDERHOOK COMMUNITY	MO3031198	CAMDEN	1999	2	P	575	223	0	100	0	0	0	0	0.3600		0.1400
OSAGE BEACH HARBOR SUBD	MO3238042	CAMDEN	1991	1	P	230	69	0	100	0	0	0	0			0.0050
OSAGE HIGHLANDS	MO3031089	CAMDEN	1995	1	P	200	104	0	100	0	0	0	0	0.0100		0.0050
OSAGE RIDGE APTS	MO3079537	MILLER	1986	1	P	150	72	0	100	0	0	0	0	0.0750	0.0080	0.0050
OUR SLICE OF PARADISE	MO1041483	BENTON	2005	1	P	35	44	0	100	0	0	0	0			0.0000
OVERLOOK SUBDIVISION	MO5031070	STONE	1994	2	P	158	77	0	100	0	0	0	0	0.0300	0.0060	0.1800
OZARK CORRECTIONAL CENTER	MO5069035	WEBSTER	1990	2	S	800	250	0	100	0	0	0	0	1.0260	0.0500	0.2200

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name	System ID Number	County Location	Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
OZARK MOUNTAIN VILLAGE HOMES	MO5036263	STONE	2014	1	P	34	20	0	100	0	0	0	0	0.0360		0.0000
OZARK PARK ESTATES	MO5048271	TANEY	1965	2	P	125	50	0	100	0	0	0	0	0.0110	0.0060	0.0050
OZARK VILLA AT SHELL KNOB	MO5071342	BARRY	2003	1	P	108	37	0	100	0	0	0	0	0.0100	0.0060	0.0400
OZARKS CWC KIMBERLING CITY CENTER WATER	MO5036046	STONE	1991	2	P	200	106	0	0	0	0	0	0	0.1400	0.0200	0.0850
PALACE LANE ESTATES	MO3048277	MILLER	1973	1	P	120	37	0	100	0	0	0	0	0.0500	0.0100	0.0060
PALISADES VILLAGE	MO6036316	JEFFERSON	1991	2	P	50	27	0	100	0	0	0	0		0.0000	0.0180
PARADISE ESTATES MHP	MO6048094	JEFFERSON	1965	1	P	58	23	0	100	0	0	0	0		0.0040	0.0010
PARADISE LANDING/KIMBERLING SHORES	MO5070476	STONE	1993	2	P	33	119	0	100	0	0	0	0	0.1400	0.0120	0.0340
PARADISE MHP	MO6048206	FRANKLIN	1959	2	P	50	35	0	100	0	0	0	0	0.0500		0.0000
PARADISE POINT RESORT LLC	MO5071269	TANEY	2004	1	P	250	172	0	100	0	0	0	0	0.2490	0.0120	0.1500

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
PARK PLACE MASTER ASSN															
System ID Number	County Location														
MO3282326	CAMDEN	1997	C2	P	545	228	0	100	0	0	0	0			0.0580
PARK PLACE MHP JOPLIN															
System ID Number	County Location														
MO5048995	NEWTON	1987	1	P	62	44	0	100	0	0	0	0		0.0030	0.0010
PARK WOODS WATER COMPANY INC															
System ID Number	County Location														
MO5031641	LAWRENCE	2017	2	P	80	30	0	100	0	0	0	0			0.0100
PARKWOOD LAKE ESTATES															
System ID Number	County Location														
MO4048083	CAPE GIRARDEAU	1970	1	P	416	128	0	100	0	0	0	0	0.0430	0.0830	0.0060
PATTERSON DUCK CLUB POA															
System ID Number	County Location														
MO5030380	STONE	1993	2	P	46	33	0	100	0	0	0	0			0.0300
PEACE OF MIND ESTATES															
System ID Number	County Location														
MO5036241	GREENE	1989	1	P	60	29	0	100	0	0	0	0	0.0010	0.0070	0.0010
PEMBROOK VILLAGE SUBD															
System ID Number	County Location														
MO5036304	GREENE	1989	2	P	64	15	0	100	0	0	0	0	0.0900		0.0060
PEMBROOKE PARK															
System ID Number	County Location														
MO1262830	JOHNSON	2007	1	P	170	48	0	0	0	0	100	0		0.0080	0.0000
PENINSULA SUBD															
System ID Number	County Location														
MO3031349	CAMDEN	2001	2	P	75	48	0	100	0	0	0	0		0.0060	0.0000
PEVELY FARM HOMEOWNERS ASSN															
System ID Number	County Location														
MO6031185	ST LOUIS	2002	C1	P	85	60	0	100	0	0	0	0	0.1400	0.0470	0.1660

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Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
PICKERING PLACE															
System ID Number	County Location														
MO1031250	CASS	1998	2	P	250	160	0	0	0	100	0	0		0.0100	0.1550
PINE FORD VILLAGE MHP															
System ID Number	County Location														
MO6048354	JEFFERSON	1989	C1	P	50	20	0	100	0	0	0	0	0.0260	0.0030	0.0430
PINE TRAILS WATER CO															
System ID Number	County Location														
MO4036308	WAYNE	1976	1	P	120	40	0	100	0	0	0	0		0.0100	0.0050
PINNACLE SHORES SUBDIVISION															
System ID Number	County Location														
MO5031540	STONE	2014	2	P	100	33	0	100	0	0	0	0			0.0370
PIONEER POINT SUBD															
System ID Number	County Location														
MO5030770	STONE	1993	2	P	72	72	0	100	0	0	0	0	0.0370	0.0030	0.0300
PIPPINVILLE & OAK PARK OWNERS ASSN															
System ID Number	County Location														
MO5036305	CHRISTIAN	1986	2	P	150	53	0	100	0	0	0	0	0.0500	0.0110	0.0150
PLANTATION ESTATES															
System ID Number	County Location														
MO5030019	POLK	2014	2	P	51	33	0	100	0	0	0	0			0.0000
PLEASANT OAK MHP															
System ID Number	County Location														
MO6048356	WARREN	1990	1	P	100	46	0	100	0	0	0	0		0.0030	0.0030
PLEASANT VALLEY ASSN 1															
System ID Number	County Location														
MO5031429	CAMDEN	2004	1	P	175	76	0	100	0	0	0	0		0.0050	0.0220
POINTE SEVEN CONDOMINIUMS															
System ID Number	County Location														
MO5031554	STONE	2014	2	P	120	44	0	100	0	0	0	0	0.1220	0.0100	0.0400

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
POM OSA HEIGHT SUBD															
System ID Number	County Location														
MO3036133	BENTON	1989	1	P	119	63	0	100	0	0	0	0	0.0200	0.0030	0.0100
PORT PERRY SERVICE															
System ID Number	County Location														
MO4036132	PERRY	1975	1	P	793	358	0	100	0	0	0	0	0.0860	0.0100	0.2320
POTOSI EAST															
System ID Number	County Location														
MO6069096	WASHINGTON	1982	2	S	1,500	4	0	100	0	0	0	0	0.7920	0.0930	0.4000
PRAIRIE HEIGHTS SUBD															
System ID Number	County Location														
MO5036140	POLK	1971	2	P	85	54	0	100	0	0	0	0	0.0720	0.0100	0.0040
PRAIRIE VIEW ACRES SUBD															
System ID Number	County Location														
MO6036022	ST CHARLES	1963	1	P	135	40	0	100	0	0	0	0	0.0960	0.0100	0.0010
QUAIL COVE SUBDIVISION															
System ID Number	County Location														
MO5030183	STONE	1992	2	P	25	14	0	100	0	0	0	0			0.0030
QUAIL CREEK MOBILE HOME PARK															
System ID Number	County Location														
MO5048365	POLK	1991	1	P	26	28	0	100	0	0	0	0		0.0050	0.0000
QUAIL RUN MHP															
System ID Number	County Location														
MO6031327	LINCOLN	2002	1	P	250	121	0	100	0	0	0	0	0.1550	0.0110	0.2960
QUAIL RUN OF IMPERIAL															
System ID Number	County Location														
MO6048258	JEFFERSON	1980	1	P	370	85	0	0	0	100	0	0	0.1350	0.0450	0.0110
RAINBOW HILLS															
System ID Number	County Location														
MO5031103	STONE	2001	2	P	29	9	0	100	0	0	0	0	0.1370		0.0100

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
RAINTREE PLANTATION															
System ID Number	County Location														
MO6036271	JEFFERSON	1985	2	L	1,300	733	0	100	0	0	0	0	0.0200	0.0470	0.2210
RED CEDAR PT HOMEOWNERS ASSN INC															
System ID Number	County Location														
MO5030930	STONE	1994	2	P	75	30	0	100	0	0	0	0	0.0150	0.0100	0.0200
RED OAK ESTATES															
System ID Number	County Location														
MO5048346	NEWTON	1990	2	P	75	35	0	100	0	0	0	0	0.0240	0.0040	0.0050
RED OAK SUBDIVISION															
System ID Number	County Location														
MO5031416	CAMDEN	2008	C1	P	25	22	0	100	0	0	0	0	0.0570	0.0030	0.0090
RIDGE CREEK WATER COMPANY LLC															
System ID Number	County Location														
MO4031631	PULASKI	2015	2	P	390	136	0	100	0	0	0	0			0.0030
RIDGETOP WATERWORKS CORP SUBDIVISION															
System ID Number	County Location														
MO4036224	WAYNE	1977	1	P	130	48	0	100	0	0	0	0	0.0280	0.0100	0.0200
RIDGEVIEW ESTATES															
System ID Number	County Location														
MO5033116	DALLAS	2014	2	P	39	11	0	100	0	0	0	0	0.0570		0.0000
RIVERFORK RANCH ESTATES															
System ID Number	County Location														
MO5036315	STONE	1989	2	P	370	154	0	100	0	0	0	0	0.1200	0.0260	0.0570
RIVERVIEW NURSING CENTER															
System ID Number	County Location														
MO3069003	CALLAWAY	1978	1	P	30	1	0	100	0	0	0	0	0.0700	0.0040	0.0000
RIVIERA SOUTH WATER CORP															
System ID Number	County Location														
MO5036314	HICKORY	1991	2	P	212	104	0	100	0	0	0	0		0.0140	0.0130

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
ROARING RIVER HOMEOWNERS ASSN INC															
System ID Number	County Location														
MO5031084	BARRY	1994	1	P	30	19	0	100	0	0	0	0	0.0280	0.0000	0.0000
ROBYN POINT															
System ID Number	County Location														
MO3030474	CAMDEN	1993	1	P	72	37	0	100	0	0	0	0	0.1440	0.0170	0.0050
ROCKPORT SUBDIVISION															
System ID Number	County Location														
MO6031493	LINCOLN	2008	1	P	204	117	0	100	0	0	0	0			0.1450
ROCKRIDGE ESTATES SUBD															
System ID Number	County Location														
MO5030781	GREENE	1991	1	P	77	25	0	100	0	0	0	0			0.0050
ROCKY TOP MOBILE HOME COURT															
System ID Number	County Location														
MO5040355	STONE	1992	1	P	51	32	0	100	0	0	0	0		0.0040	0.0000
ROGUE CREEK UTILITIES															
System ID Number	County Location														
MO4036318	WASHINGTON	1971	C1	P	200	87	0	100	0	0	0	0	0.0200	0.0170	0.0080
ROLLIN ACRES SUBDIVISION															
System ID Number	County Location														
MO5036319	STONE	1990	2	P	45	25	0	100	0	0	0	0	0.2500	0.0030	0.0040
ROLLING MEADOWS															
System ID Number	County Location														
MO5048344	TANEY	1989	2	P	156	78	0	100	0	0	0	0	0.1220	0.0160	0.0310
ROUTE 66 HOMES															
System ID Number	County Location														
MO4043109	CRAWFORD	2013	2	P	35	15	0	100	0	0	0	0			0.0000
ROXBOROUGH MHP															
System ID Number	County Location														
MO5040057	STONE	1992	2	P	57	34	0	100	0	0	0	0	0.0360	0.0080	0.0070

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
ROY L UTILITIES															
System ID Number	County Location														
MO6251710	MONTGOMERY	1989	1	P	30	59	0	100	0	0	0	0			0.0190
ROYAL LAKE ESTATES															
System ID Number	County Location														
MO4031334	CAPE GIRARDEAU	2011	1	P	50	14	0	100	0	0	0	0		0.0110	0.0270
S K & M WATER COUNTY INC															
System ID Number	County Location														
MO4036226	PERRY	1975	1	P	733	296	0	100	0	0	0	0	0.2130	0.2130	0.0960
SCHOONER BAY LANDING SUBDIVISION															
System ID Number	County Location														
MO5036350	STONE	1978	2	P	100	172	0	100	0	0	0	0	0.1410	0.0120	0.0250
SCOTSDALE SUBD															
System ID Number	County Location														
MO6036062	JEFFERSON	1963	1	P	120	28	0	100	0	0	0	0		0.0150	0.0750
SCOTTSDALE PARK PROPERTY OWNERS ASSN															
System ID Number	County Location														
MO5036353	STONE	1998	2	P	62	30	0	100	0	0	0	0			0.0050
SEGES MOBILE HOME PARK															
System ID Number	County Location														
MO2041558	CALLAWAY	2007	1	P	285	60	0	0	0	0	100	0			0.0000
SERENITY BAY SUBD															
System ID Number	County Location														
MO3031242	CAMDEN	1998	1	P	65	26	0	100	0	0	0	0	0.1300	0.0090	0.0000
SEVEN TRAILS WEST SUBD															
System ID Number	County Location														
MO3031220	CAMDEN	1998	1	P	435	145	0	100	0	0	0	0		0.0160	0.0470
SHADY ACRES MHP															
System ID Number	County Location														
MO5048013	GREENE	1991	1	P	114	34	0	100	0	0	0	0	0.0290	0.0080	0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
SHADY LANE SUBDIVISION															
System ID Number	County Location														
MO5033107	NEWTON	2014	1	P	45	18	0	100	0	0	0	0			0.0000
SHADY LANE TRAILER PARK															
System ID Number	County Location														
MO3048122	PHELPS	1970	1	P	48	16	0	100	0	0	0	0	0.0150	0.0030	0.0000
SHADY OAK MHP															
System ID Number	County Location														
MO5048231	WRIGHT	1989	2	P	65	26	0	100	0	0	0	0		0.0020	0.0000
SHALOM MOUNTAIN															
System ID Number	County Location														
MO3031302	PULASKI	2007	1	P	228	112	0	100	0	0	0	0		0.2830	0.0570
SHELL ROCK UTILITIES															
System ID Number	County Location														
MO5036168	BARRY	1989	1	P	45	65	0	100	0	0	0	0	0.1080	0.0010	0.0180
SHERWOOD SUBD OWNER ASSN															
System ID Number	County Location														
MO5036265	STONE	1969	2	P	90	38	0	100	0	0	0	0	0.0570	0.0020	0.0050
SHOW ME CHRISTIAN YOUTH HOME															
System ID Number	County Location														
MO1061484	PETTIS	2006	2	P	62	8	0	100	0	0	0	0			0.0000
SILO RIDGE															
System ID Number	County Location														
MO5031210	POLK	1998	2	P	400	30	0	100	0	0	0	0			0.0130
SILVER BELL MOBILE HOME PARK															
System ID Number	County Location														
MO5048145	GREENE	1968	2	P	300	103	0	100	0	0	0	0	0.1500	0.0110	0.0210
SKY BLUE WATER INC															
System ID Number	County Location														
MO5031173	MCDONALD	1996	2	P	75	34	0	100	0	0	0	0	0.0500	0.0020	0.0120

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
SOUTH OAKS MHP															
System ID Number	County Location														
MO5048394	CHRISTIAN	1987	2	P	150	75	0	100	0	0	0	0	0.1080	0.0100	0.0000
SOUTH SHORE WATER ASSN															
System ID Number	County Location														
MO6030528	JEFFERSON	1993	1	P	75	18	0	100	0	0	0	0	0.0060	0.0060	0.0000
SOUTH SIDE WATER ASSN															
System ID Number	County Location														
MO1033103	BENTON	2013	1	L	62	10	0	100	0	0	0	0			0.0000
SOUTHERN HILLS WATER CO															
System ID Number	County Location														
MO3036065	PETTIS	1986	2	P	144	48	0	100	0	0	0	0	0.0160	0.0160	0.0000
SOUTHFIELD SUBDIVISION															
System ID Number	County Location														
MO6031274	LINCOLN	2002	1	P	25	20	0	100	0	0	0	0	0.0150	0.0060	0.0030
SOUTHFORK MHP															
System ID Number	County Location														
MO1048442	CASS	1991	1	P	745	324	0	0	0	50	50	0		0.0250	0.0000
SOUTHGATE SUBDIVISION															
System ID Number	County Location														
MO3036179	PETTIS	1992	1	P	216	69	0	100	0	0	0	0	0.0600	0.0200	0.0080
SOUTHPORT CONDOMINIUMS															
System ID Number	County Location														
MO5071255	STONE	1998	2	P	72	36	0	100	0	0	0	0		0.0050	0.0100
SOUTHVIEW MHP & RV CAMP															
System ID Number	County Location														
MO1041487	BENTON	2006	1	P	100	70	0	100	0	0	0	0			0.0000
SOUTHWAY TERRACE MHP															
System ID Number	County Location														
MO3048141	CAMDEN	1970	2	P	75	22	0	100	0	0	0	0		0.0070	0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name	County Location	Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
SOUTHWOOD ACRES SUBD															
System ID Number	County Location														
MO3036066	PETTIS	1967	1	P	35	20	0	100	0	0	0	0	0.0450	0.0070	0.0100
SPARTA MHP															
System ID Number	County Location														
MO5048154	CHRISTIAN	1971	1	P	33	30	0	100	0	0	0	0	0.0430	0.0050	0.0000
SPOKANE HIGHLANDS															
System ID Number	County Location														
MO5031093	CHRISTIAN	1994	2	P	250	49	0	100	0	0	0	0	0.1000	0.0080	0.0150
SPRING MEADOWS MHP															
System ID Number	County Location														
MO6048249	FRANKLIN	1987	1	P	132	27	0	100	0	0	0	0	0.0000	0.0020	0.0000
SPRINGDALE LAKE ESTATES															
System ID Number	County Location														
MO1048081	CASS	2011	2	P	1,100	338	0	0	0	80	20	0		0.0530	0.0000
ST CHARLES COUNTY PWSD 2 HICKORY TRAILS															
System ID Number	County Location														
MO6021531	WARREN	2010	D2	P	50	20	0	100	0	0	0	0	0.0050	0.0020	1.5000
ST CHARLES COUNTY PWSD 2 NORTH OAK DR															
System ID Number	County Location														
MO6021633	WARREN	2015	D1	L	580	220	0	100	0	0	0	0			0.1000
ST CHARLES COUNTY PWSD 2 SUMAC RIDGE															
System ID Number	County Location														
MO6031209	ST CHARLES	1999	1	P	126	37	0	100	0	0	0	0		0.0080	0.0080
ST MARYS SEMINARY															
System ID Number	County Location														
MO4069016	PERRY	1999	C1	P	30	1	0	100	0	0	0	0			0.0500

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
ST TROPEZ SUBDIVISION															
System ID Number	County Location														
MO3031279	CAMDEN	1999	1	P	75	29	0	100	0	0	0	0			0.0000
STARRLITE VILLAGE 4TH ADDITION															
System ID Number	County Location														
MO5258070	STONE	2003	1	P	55	22	0	100	0	0	0	0			0.0000
STARRVILLE PARK															
System ID Number	County Location														
MO5242478	STONE	2000	2	P	100	63	0	100	0	0	0	0		0.0090	0.0100
STATELY MANSION MOBILE VILLA															
System ID Number	County Location														
MO3048123	PHELPS	1969	1	P	100	10	0	100	0	0	0	0	0.0700	0.0130	0.0110
STERETT CREEK VILLAGE															
System ID Number	County Location														
MO3252288	BENTON	1992	2	P	250	180	0	100	0	0	0	0		0.0010	0.0110
STOCKTON HILLS WATER CO															
System ID Number	County Location														
MO5036164	CEDAR	1991	1	P	355	142	0	100	0	0	0	0	0.0370	0.0120	0.0400
STONEBRIDGE WEST SUBD															
System ID Number	County Location														
MO5036201	STONE	1991	2	P	135	60	0	100	0	0	0	0	0.0190	0.0030	0.0270
STONECROFT CONFERENCE CENTER															
System ID Number	County Location														
MO5271012	TANEY	2006	2	P	25	7	0	100	0	0	0	0	0.0860	0.0100	0.0140
STONES MHP															
System ID Number	County Location														
MO5041213	STONE	2001	2	P	50	32	0	100	0	0	0	0	0.0360	0.0040	0.0110
STONEY RIDGE VILLAGE															
System ID Number	County Location														
MO3069089	PETTIS	2016	1	P	54	1	0	100	0	0	0	0	0.0500	0.0100	0.0010

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
SUBURBAN ACRES MOBILE HOME PARK															
System ID Number	County Location														
MO5048400	GREENE	1991	1	P	128	51	0	100	0	0	0	0	0.1800	0.0000	0.0000
SUGAR CREEK ESTATES MHP															
System ID Number	County Location														
MO6046277	JEFFERSON	2016	1	P	500	1	0	0	0	100	0	0			0.0000
SUGAR TREE CLUB															
System ID Number	County Location														
MO3031211	PHELPS	1997	1	P	66	21	0	100	0	0	0	0	0.0600	0.0060	0.0040
SUMMER PLACE ON THE LAKE															
System ID Number	County Location														
MO3031257	CAMDEN	2001	2	P	100	133	0	100	0	0	0	0		0.0210	0.0410
SUMMER SET UTILITY CO															
System ID Number	County Location														
MO6036031	JEFFERSON	1973	2	P	990	414	0	100	0	0	0	0	0.1220	0.0830	0.2200
SUMMERHAVEN SUBDIVISION															
System ID Number	County Location														
MO6036279	LINCOLN	2016	1	P	75	23	0	100	0	0	0	0			0.0000
SUNDOWN WATER SYSTEM INC															
System ID Number	County Location														
MO5030209	OZARK	1992	1	P	60	29	0	100	0	0	0	0	0.0290	0.0050	0.0100
SUNRISE LAKES SUBD															
System ID Number	County Location														
MO6036080	JEFFERSON	1989	2	P	400	147	0	100	0	0	0	0	0.6000	0.0700	0.0190
SUNSET HEIGHTS 2ND ADDITION															
System ID Number	County Location														
MO5036054	CHRISTIAN	1990	1	P	30	14	0	100	0	0	0	0	0.0250	0.0030	0.0000
SUNSET HEIGHTS SUBD WELL 2 BLOCK 2															
System ID Number	County Location														
MO5036092	CHRISTIAN	1991	1	P	25	15	0	100	0	0	0	0		0.0020	0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
SUNSET MHP															
System ID Number	County Location														
MO5031430	MILLER	2004	1	P	75	33	0	100	0	0	0	0			0.0000
MO5048021	JASPER	1990	1	P	80	32	0	100	0	0	0	0	0.0540	0.0080	0.0010
SUNSHINE ESTATES															
System ID Number	County Location														
MO5031606	POLK	2009	2	P	60	19	0	100	0	0	0	0		0.0020	0.0280
SUNSHINE HOME CARE															
System ID Number	County Location														
MO6061638	ST CHARLES	2017	1	P	36	2	0	100	0	0	0	0		0.0020	0.0000
SUSSEX PARK SUBD															
System ID Number	County Location														
MO5036150	GREENE	1970	2	P	130	50	0	100	0	0	0	0	0.1080	0.0070	0.0090
SWEETWATER BEACH SUBD															
System ID Number	County Location														
MO5031340	BARRY	2000	2	P	63	59	0	100	0	0	0	0			0.0170
SYCAMORE GREEN ACRES MHP															
System ID Number	County Location														
MO6048052	JEFFERSON	1972	1	P	50	32	0	100	0	0	0	0	0.0860		0.0050
SYCAMORE LANDING ASSN															
System ID Number	County Location														
MO5036253	STONE	1991	2	P	70	35	0	100	0	0	0	0	0.0430	0.0040	0.0100
SYCAMORE RIDGE SUBDIVISION															
System ID Number	County Location														
MO5031437	TANEY	2007	2	P	300	48	0	100	0	0	0	0	0.0210	0.0100	0.0760
SYCAMORE SPRINGS															
System ID Number	County Location														
MO6048401	JEFFERSON	1989	2	P	188	161	0	100	0	0	0	0	0.0590	0.0170	0.0940

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
SYCAMORE VALLEY SUBD															
System ID Number	County Location														
MO3036127	BENTON	1999	1	P	304	98	0	100	0	0	0	0	0.0500	0.0130	0.0000
SYLVAN BAY SUBDIVISION															
System ID Number	County Location														
MO3031280	CAMDEN	1999	1	P	75	42	0	100	0	0	0	0			0.0040
SYLVAN MANOR SUBD															
System ID Number	County Location														
MO6036085	FRANKLIN	1956	1	P	240	76	0	100	0	0	0	0	0.0200	0.0060	0.0000
TABLE ROCK ESTATES SUBD															
System ID Number	County Location														
MO5036232	STONE	1990	2	P	50	35	0	100	0	0	0	0	0.0360	0.0030	0.0100
TABLE ROCK HEIGHTS HOME OWNERS ASSN															
System ID Number	County Location														
MO5030442	TANEY	1992	1	P	50	23	0	100	0	0	0	0	0.0860	0.0030	0.0100
TABLE ROCK RETIREMENT VILLAGE															
System ID Number	County Location														
MO5069084	STONE	1982	1	P	216	49	0	100	0	0	0	0	0.4320	0.1000	0.1000
TALL OAKS MHP															
System ID Number	County Location														
MO6048201	FRANKLIN	2006	2	P	120	51	0	100	0	0	0	0	0.0150	0.0100	0.0010
TANEY COUNTY PWSD #2 - CEDAR MEADOWS															
System ID Number	County Location														
MO5029099	TANEY	2016	1	L	63	25	0	100	0	0	0	0			0.0300
TANEY COUNTY WATER LLC LAKEWAY															
System ID Number	County Location														
MO5036223	TANEY	1987	1	P	370	82	0	100	0	0	0	0	0.1580	0.0210	0.0240

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
TANEY COUNTY WATER LLC VENICE															
System ID Number	County Location														
MO5036180	TANEY	1991	2	P	1,100	380	0	100	0	0	0	0	0.1700	0.0700	0.0270
TANEYCOMO HIGHLANDS SUBD INC															
System ID Number	County Location														
MO5031159	TANEY	1996	2	P	68	34	0	100	0	0	0	0	0.0280	0.0020	0.0060
TANGLEWOOD MOBILE COURT															
System ID Number	County Location														
MO3048124	PHELPS	1970	1	P	90	32	0	100	0	0	0	0	0.0150	0.0000	0.0000
TARA OAKS MANOR ASSN															
System ID Number	County Location														
MO6036136	ST CHARLES	1990	C1	P	100	36	0	100	0	0	0	0	0.0720	0.0020	0.0040
TARA VALLEY WATER ASSN															
System ID Number	County Location														
MO6031193	LINCOLN	1997	C1	P	60	30	0	100	0	0	0	0	0.0500	0.0000	0.0050
TERRE DU LAC															
System ID Number	County Location														
MO4036059	ST FRANCOIS	1968	2	P	3,217	1,301	0	100	0	0	0	0	0.6480	0.2250	0.1500
THE FALLS CONDOMINIUMS															
System ID Number	County Location														
MO3238097	CAMDEN	1991	1	P	275	127	0	100	0	0	0	0		0.0090	0.0060
THE KNOLLS															
System ID Number	County Location														
MO3252255	CAMDEN	1982	2	P	725	291	0	100	0	0	0	0	0.0220		0.0210
THE LANDING SUBDIVISION															
System ID Number	County Location														
MO5036218	GREENE	1992	2	P	37	37	0	100	0	0	0	0	0.0720	0.0130	0.0200
THE LEGACY RANCH															
System ID Number	County Location														
MO4071640	WASHINGTON	2017	1	P	25	1	0	100	0	0	0	0			0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
THE MISSING WELL															
System ID Number	County Location														
MO3031366	BENTON	2002	2	P	170	68	0	100	0	0	0	0		0.0010	0.0000
THE WILLOWS UTILITY COMPANY															
System ID Number	County Location														
MO5048099	GREENE	1970	2	P	275	210	0	100	0	0	0	0	0.2880	0.0340	0.0470
TIMBER RIDGE ESTATES															
System ID Number	County Location														
MO6031217	LINCOLN	1997	1	P	40	15	0	100	0	0	0	0			0.0010
TIMBERLAKE MASTER ASSN INC															
System ID Number	County Location														
MO3031365	MORGAN	2009	1	P	300	151	0	100	0	0	0	0		0.0140	0.0280
TIMBERLOST MHP															
System ID Number	County Location														
MO5048274	NEWTON	1990	2	P	150	51	0	100	0	0	0	0		0.0000	0.0040
TONYS POINT															
System ID Number	County Location														
MO5031399	MORGAN	2003	1	P	75	44	0	100	0	0	0	0			0.0000
TOWN & COUNTRY MHP															
System ID Number	County Location														
MO5048224	NEWTON	1990	2	P	77	33	0	100	0	0	0	0		0.0050	0.0000
TOWN OF CHARMWOOD															
System ID Number	County Location														
MO6030106	FRANKLIN	1992	1	P	28	13	0	100	0	0	0	0		0.0020	0.0000
TOWN OF MARTIN															
System ID Number	County Location														
MO3031246	MARIES	1998	1	L	29	13	0	100	0	0	0	0		0.0010	0.0000
TREEHOUSE CONDOMINIUMS															
System ID Number	County Location														
MO5036352	STONE	1987	2	P	516	172	0	100	0	0	0	0		0.0200	0.0010

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
TRI COUNTY WATER AUTHORITY															
System ID Number	County Location														
MO1071079	JACKSON	1993	C3	L	25	31	0	100	0	0	0	0	10.5000	3.4000	12.2500
TRIPLE L TRAILER PARK															
System ID Number	County Location														
MO1041639	ANDREW	2017	1	P	52	18	0	0	0	0	100	0		0.0050	0.0000
TT SEWER															
System ID Number	County Location														
MO3071339	CAMDEN	2008	1	P	275	100	0	100	0	0	0	0	0.0570		0.0000
TUK LLC															
System ID Number	County Location														
MO6036053	JEFFERSON	1964	2	P	300	83	0	100	0	0	0	0	0.1300	0.0200	0.0300
TURNER ESTATES SUBD															
System ID Number	County Location														
MO5036312	STONE	1991	2	P	25	40	0	100	0	0	0	0		0.0040	0.0070
TUSCANY CONDOMINIUMS															
System ID Number	County Location														
MO5301390	CAMDEN	2005	2	P	140	56	0	100	0	0	0	0			0.0350
TWILITE HOME SITES															
System ID Number	County Location														
MO5031277	TANEY	1999	1	P	28	21	0	100	0	0	0	0	0.0210		0.0000
TWIN ISLAND ESTATES															
System ID Number	County Location														
MO5036186	STONE	1989	2	P	525	219	0	100	0	0	0	0	0.2950	0.0280	0.0920
TWIN ISLAND HGTS HOME OWNERS ASSN															
System ID Number	County Location														
MO5030088	STONE	1992	2	P	200	93	0	100	0	0	0	0	0.1650	0.0130	0.0250
TWIN LAKES MOBILE HOME AND RV PARK LLC															
System ID Number	County Location														
MO1041486	BENTON	2006	1	P	45	18	0	100	0	0	0	0			0.0000

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
TWIN OAKS HARBOR															
System ID Number	County Location														
MO5240546	ST CLAIR	1992	1	P	50	102	0	100	0	0	0	0			0.0000
TWIN RIDGES PARK INC															
System ID Number	County Location														
MO5048032	CHRISTIAN	1991	C2	P	125	51	0	100	0	0	0	0		0.0100	0.0110
TWIN RIVERS SUBD															
System ID Number	County Location														
MO5036195	BARRY	1990	2	P	72	36	0	100	0	0	0	0	0.0360	0.0050	0.0150
UNIVERSITY OF MISSOURI COLUMBIA															
System ID Number	County Location														
MO3069001	BOONE	1988	3	S	35,000	226	0	100	0	0	0	0	6.4850	2.2000	2.7500
UPPER BEND ROAD SUBDIVISION															
System ID Number	County Location														
MO4030289	CAPE GIRARDEAU	1992	1	P	63	21	0	100	0	0	0	0	0.0280		0.0000
USACE MINGO JOB CORPS CCC															
System ID Number	County Location														
MO4069053	STODDARD	1991	2	F	225	20	0	100	0	0	0	0	0.2160	0.0100	0.1200
VALLE ACRES MHP															
System ID Number	County Location														
MO6048208	JEFFERSON	1991	1	P	25	11	0	100	0	0	0	0	0.0280	0.0020	0.0000
VALLE LAKE SUBD															
System ID Number	County Location														
MO6036083	JEFFERSON	1957	2	P	625	290	0	100	0	0	0	0	0.0930	0.0060	0.0600
VALLEY LAKE ESTATES															
System ID Number	County Location														
MO6030922	WARREN	1994	1	P	40	19	0	100	0	0	0	0	0.4600	0.0060	0.0010
VALLEY WOODS SUBDIVISION															
System ID Number	County Location														
MO5031152	CHRISTIAN	1995	2	P	120	39	0	100	0	0	0	0	0.1220		0.0090

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
VAUGHN TRAILER PARK															
System ID Number	County Location														
MO5048020	LAWRENCE	1972	1	P	50	22	0	100	0	0	0	0	0.0720	0.0080	0.0020
VILLAGE GREENS															
System ID Number	County Location														
MO6031382	FRANKLIN	2004	1	P	150	79	0	100	0	0	0	0	1.4400	0.0130	0.0120
VILLAGE OF CONEY ISLAND															
System ID Number	County Location														
MO5036090	STONE	1959	2	P	175	109	0	100	0	0	0	0	0.0430	0.0080	0.0500
VILLAGE OF MC CORD BEND															
System ID Number	County Location														
MO5036205	STONE	1990	1	P	205	49	0	100	0	0	0	0	0.0500	0.0200	0.0850
W E SEARS YOUTH CENTER															
System ID Number	County Location														
MO4069038	BUTLER	1988	2	S	140	32	0	100	0	0	0	0	0.1360	0.0100	0.0350
WADSWORTH PARK UNIT 4 AND 5															
System ID Number	County Location														
MO5036109	GREENE	1990	1	P	100	40	0	100	0	0	0	0	0.1650	0.0100	0.0100
WALKER HILL MHP															
System ID Number	County Location														
MO6041184	JEFFERSON	2010	1	P	30	6	0	100	0	0	0	0			0.0000
WALKER MOBILE HOME PARK															
System ID Number	County Location														
MO5048992	TANEY	1991	2	P	52	20	0	100	0	0	0	0	0.0430	0.0030	0.0000
WALL EYE HAVEN MHP															
System ID Number	County Location														
MO5048214	TANEY	1990	2	P	50	30	0	100	0	0	0	0	0.0170	0.0030	0.0010
WALNUT GROVE MHP															
System ID Number	County Location														
MO4041308	ST FRANCOIS	2003	C1	P	135	50	0	100	0	0	0	0		0.0090	0.0200

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
WARE LAKE SUBD															
System ID Number	County Location														
MO6036148	JEFFERSON	1991	2	P	100	37	0	100	0	0	0	0	0.1500	0.0300	0.0000
WARREN WOODS SUBD															
System ID Number	County Location														
MO6036084	JEFFERSON	1961	2	P	60	20	0	100	0	0	0	0	0.0350	0.0080	0.0000
WARRENS OAKLAND PARK															
System ID Number	County Location														
MO5043117	STONE	2014	1	P	52	21	0	100	0	0	0	0		0.0050	0.0000
WATKINS SUBDIVISION															
System ID Number	County Location														
MO5031401	CAMDEN	2003	2	P	70	27	0	100	0	0	0	0		0.0070	0.0090
WESTLAKE MEADOWS SUBDIVISION															
System ID Number	County Location														
MO4031453	CAPE GIRARDEAU	2005	C1	P	46	22	0	100	0	0	0	0			0.0000
WESTMIER SUBDIVISION															
System ID Number	County Location														
MO6031324	LINCOLN	2003	1	P	82	33	0	100	0	0	0	0	0.0720	0.0080	0.0040
WESTVIEW MOBILE HOME PARK															
System ID Number	County Location														
MO6048272	FRANKLIN	1991	1	P	51	48	0	100	0	0	0	0		0.0050	0.0050
WHISPERING HILLS SUBD															
System ID Number	County Location														
MO3036251	CAMDEN	1973	2	P	190	85	0	100	0	0	0	0	0.0500	0.0150	0.0040
WHISPERING HILLS SUBDIVISION															
System ID Number	County Location														
MO4036095	WAYNE	1972	1	P	180	60	0	100	0	0	0	0	0.0000	0.0050	0.0000
WHITE EAGLE WOODS MHP															
System ID Number	County Location														
MO5190587	STONE	1993	2	P	80	45	0	100	0	0	0	0	0.0490	0.0060	0.0250

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
WHITE PINE VILLAGE															
System ID Number	County Location														
MO5048267	CHRISTIAN	1990	2	P	80	44	0	100	0	0	0	0	0.0460	0.0080	0.0010
WHITEMAN AIR BASE															
System ID Number	County Location														
MO1079501	JOHNSON	1964	B2	F	7,886	1,094	0	100	0	0	0	0	2.7000	0.6000	1.8180
WHITESIDE HIDDEN ACRES															
System ID Number	County Location														
MO5208303	HICKORY	1991	1	P	92	37	0	100	0	0	0	0		0.0080	0.0000
WILDEN HEIGHTS HOA															
System ID Number	County Location														
MO5036192	GREENE	1992	1	P	58	23	0	100	0	0	0	0	0.0580	0.0040	0.0010
WILDERNESS PINEWOOD WATER SERVICE TRUST															
System ID Number	County Location														
MO5031102	TANEY	1995	2	P	218	109	0	100	0	0	0	0	0.1290	0.0100	0.0300
WILDFLOWER HOA															
System ID Number	County Location														
MO5031141	STONE	2005	2	P	60	33	0	100	0	0	0	0		0.0120	0.0200
WILDWOOD LOT OWNERS ASSN															
System ID Number	County Location														
MO3242162	CALLAWAY	1973	1	P	113	61	0	100	0	0	0	0	0.2300	0.0150	0.0160
WINDSOR APARTMENTS															
System ID Number	County Location														
MO3302411	PULASKI	2016	1	P	60	16	0	100	0	0	0	0			0.0000
WINDWOOD ESTATES SUBD															
System ID Number	County Location														
MO4031196	CAPE GIRARDEAU	1997	1	P	160	55	0	100	0	0	0	0		0.0120	0.0100
WINEGARS TEAL BEND SUBD															
System ID Number	County Location														
MO3036121	BENTON	1950	1	P	400	154	0	100	0	0	0	0	0.1700	0.0150	0.0140

Subdivision, Mobile Home Park, Institution, Miscellaneous Water Systems

Community Water System Name		Year Began	Operator Level	Owner Code	Population Served	Service Connections	Pct Sur Water	Pct Grd Water	Pct GW Under Infl	Pct Pur Sur Water	Pct Pur Grd Water	Pct Pur GW Und Infl	Supply Capacity MGD	Avg Daily Consumption MGD	Finished Water Storage
WOOD RIDGE ESTATES															
System ID Number	County Location														
MO5036071	STONE	1989	2	P	80	46	0	100	0	0	0	0	0.0570	0.0100	0.0180
WOODLAND HILLS SUBD															
System ID Number	County Location														
MO6036269	FRANKLIN	1971	1	P	110	36	0	100	0	0	0	0	0.0220	0.0100	0.0020
WOODRIDGE APARTMENTS															
System ID Number	County Location														
MO6036061	JEFFERSON	1963	1	P	70	25	0	100	0	0	0	0	0.0580	0.0050	0.0000
WOOLERY MHP															
System ID Number	County Location														
MO1041587	PETTIS	2008	1	P	45	19	0	100	0	0	0	0			0.0000
YOUNGBERG ESTATES MHP															
System ID Number	County Location														
MO5041314	LAWRENCE	2000	1	P	112	18	0	100	0	0	0	0			0.0000
ZWANZIG MHP															
System ID Number	County Location														
MO3041171	MORGAN	1996	1	P	45	21	0	100	0	0	0	0			0.0000

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
ADAIR COUNTY PWSD 1	BRASHEAR PWS
	LAPLATA PWS
	MACON COUNTY PWSD 1
	NOVINGER PWS
ADRIAN PWS	BATES COUNTY PWSD 5
ALBANY PWS	GENTRY COUNTY PWSD 1
ANDREW COUNTY PWSD 1	AMAZONIA PWS
ANDREW COUNTY PWSD 2	DEKALB COUNTY PWSD 1
	UNION STAR PWS
ANDREW COUNTY PWSD 3	FILLMORE PWS
ANDREW COUNTY PWSD 4	ANDREW COUNTY PWSD 2
	ROSENDALE PWS
ATCHISON COUNT WHOLESALE WATER COMMISSIO	FAIRFAX PWS
	ROCK PORT PWS
	TARKIO BOARD OF PUBLIC WORKS
BATES COUNTY PWSD 2	AMORET PWS
	BATES COUNTY PWSD 4
BELTON PWS	CASS COUNTY PWSD 8
	CROWN MOBILE HOME PARK
	NW CASS COUNTY SEWER & WATER DISTRICT
	SOUTHFORK MHP
BERNIE PWS	STODDARD COUNTY PWSD 6
	STODDARD COUNTY PWSD 7
BLOOMFIELD PWS	STODDARD COUNTY PWSD 5
BOLCKOW PWS	ANDREW COUNTY PWSD 4

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
BOONE COUNTY CONS PWSD 1	GREEN HILLS MHP
	HARRISBURG PWS
BOONE COUNTY PWSD 10	CLARK PWS
	STURGEON PWS
BOONE COUNTY PWSD 4	HALLSVILLE PWS
BOONVILLE PWS	COOPER COUNTY CONSOLIDATED PWSD # 1
BOURBON CO RWD 2C	VERNON COUNTY PWSD 7
BROOKFIELD PWS	CHARITON LINN COUNTY PWSD 3
	LACLEDE PWS
BUCHANAN COUNTY PWSD 1	DEKALB PWS
BUCKNER PWS	LEVASY PWS
	SIBLEY PWS
BUTLER COUNTY PWSD 1	NEELYVILLE PWS
BUTLER PWS	BATES COUNTY PWSD 1
	BATES COUNTY PWSD 3
	BATES COUNTY PWSD 4
	BATES COUNTY PWSD 6
CALLAWAY 2 WATER DISTRICT	NEW CHRISTIAN LIFE FELLOWSHIP
CALLAWAY COUNTY PWSD 1	MO AMERICAN JEFFERSON CITY NORTH
	SEGES MOBILE HOME PARK
CAMERON PWS	CLINTON COUNTY PWSD 3
CARROLL COUNTY PWSD 1	BOGARD PWS
	DEWITT PWS
	TINA PWS

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
CARTERVILLE PWS	JASPER COUNTY PWSD 3
CASS COUNTY PWSD 11	CREIGHTON PWS
CASS COUNTY PWSD 2	CLEVELAND PWS
	PECULIAR PWS
	PICKERING PLACE
CASS COUNTY PWSD 4	CASS COUNTY PWSD 9
CASS COUNTY PWSD 7	FREEMAN PWS
CHARITON LINN COUNTY PWSD 3	BUCKLIN PWS
	CHARITON COUNTY PWSD 2
	MENDON PWS
CHARLESTON PWS	MISSISSIPPI COUNTY PWSD 1
CHILLICOTHE MUNICIPAL UTILITIES	LIVINGSTON COUNTY PWSD 1
	LIVINGSTON COUNTY PWSD 2
	LIVINGSTON COUNTY PWSD 3 EAST

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
CLARENCE CANNON WHOLESALE WTR COMM	BOWLING GREEN PWS
	CANNON PWSD 1
	CLARENCE PWS
	CURRYVILLE PWS
	EDINA PWS
	FARBER PWS
	HUNTSVILLE PWS
	KNOX COUNTY PUBLIC WATER & SEWER DIST 1
	LA BELLE PWS
	LEWIS COUNTY PWSD 1
	LEWISTOWN PWS
	MACON COUNTY PWSD 1
	MADISON PWS
	MARION COUNTY PWSD 1
	MONROE COUNTY PWSD 2
	NEW LONDON PWS
	PARIS PWS
	PERRY PWS
	PIKE COUNTY PWSD 1
	SHELBY COUNTY PWSD 1
	SHELBYVILLE PWS
	THOMAS HILL PWSD 1
	WELLSVILLE PWS
CLARK COUNTY CONS PWSD 1	WYACONDA PWS
CLAY COUNTY PWSD 4	CLAY COUNTY PWSD 7
	MISSOURI CITY PWS
CLINTON COUNTY PWSD 4 SYS 1	CALDWELL COUNTY PWSD 3
	CLINTON COUNTY PWSD 3

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
CLINTON COUNTY PWSD 4 SYS 2	CLINTON COUNTY PWSD 4 SYS 1
COLUMBIA PWS	BLUE ACRES MHP
CONCORDIA PWS	EMMA PWS
	LAF/JO/SALINE COUNTY CONS PWSD 2
CORDER PWS	ALMA PWS
	LAF/JO/SALINE COUNTY CONS PWSD 2
CRAIG PWS	BIG LAKE VILLAGE OF PWS
	HOLT COUNTY PWSD 1
DAVIESS COUNTY PWSD 1	ALTAMONT PWS
DAVIESS COUNTY PWSD 2	BRECKENRIDGE PWS
	HAMILTON PWS
DEKALB COUNTY PWSD 1	CLARKSDALE PWS
	EASTON PWS
	GOWER PWS
	STEWARTSVILLE PWS
DIXON PWS	PULASKI COUNTY PWSD 3
DUENWEG PWS	JASPER COUNTY PWSD 3
EAST PRAIRIE PWS	ANNISTON PWS
	MISSISSIPPI COUNTY PWSD 1
EMMA PWS	PETTIS/JOHNSON/SALINE PWSD 1
EXCELSIOR SPRINGS PWS	CLAY COUNTY PWSD 3
	LAWSON PWS
	PRATHERSVILLE PWS
	RAY COUNTY PWSD 1

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
FISK PWS	BUTLER COUNTY PWSD 104
FORT SCOTT	VERNON COUNTY PWSD 7
GALLATIN PWS	DAVIESS COUNTY PWSD 2
GENTRY COUNTY PWSD 1	NEW HAMPTON PWS
GLASGOW PWS	HOWARD COUNTY PWSD 2
GRANT CITY PWS	PARNELL PWS
GREEN CITY PWS	GREEN CASTLE PWS
GRUNDY COUNTY PWSD 1	GALT PWS
	SPICKARD PWS
HAMILTON PWS	CALDWELL COUNTY PWSD 2
HANNIBAL PWS	RALLS COUNTY PWSD 1
HARRISON COUNTY PWSD 2	CAINSVILLE PWS
	COFFEY PWS
	DAVIESS COUNTY PWSD 2
	GILMAN CITY PWS
	HARRISON COUNTY PWSD 1
	RIDGEWAY PWS
HARRY S TRUMAN PWSD 2	APPLETON CITY PWS
	BATES COUNTY PWSD 6
	BATES COUNTY PWSD 7
	DEEPWATER PWS
	HENRY COUNTY PWSD 1
	MONTROSE PWS
	ROCKVILLE PWS

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
HENRY COUNTY PWSD 3	CALHOUN PWS
	HENRY COUNTY PWSD 4
HENRY COUNTY PWSD 4	BLAIRSTOWN PWS
	URICH PWS
HENRY COUNTY WATER COMPANY	HENRY COUNTY PWSD 3
HIGGINSVILLE PWS	CORDER PWS
	LAF/JO/SALINE COUNTY CONS PWSD 2
	MAYVIEW PWS
HOLCOMB PWS	DUNKLIN COUNTY PWSD 3 NORTH
INDEPENDENCE PWS	BLUE SPRINGS PWS
	BUCKNER PWS
	GRAIN VALLEY PWS
	HIGHLAND MANOR
	JACKSON COUNTY PWSD 15
	JACKSON COUNTY PWSD 16
	JACKSON COUNTY PWSD 17
	JACKSON COUNTY PWSD 2
	LAFAYETTE COUNTY PWSD 1
	LAKE TAPAWINGO PWS
	LEES SUMMIT PWS
	OAK GROVE PWS
	SUGAR CREEK PWS
JEFFERSON COUNTY CONS PWSD C 1	QUAIL RUN OF IMPERIAL
JEFFERSON COUNTY PWSD 2	SUGAR CREEK ESTATES MHP
JEFFERSON COUNTY WATER AUTHORITY	FESTUS PWS
	HERCULANEUM PWS

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
JOHNSON COUNTY PWSD 1	CENTERVIEW PWS
JOHNSON COUNTY PWSD 2	CHILHOWEE PWS
	KINGSVILLE PWS
JONESBURG PWS	MONTGOMERY COUNTY PWSD 1 JONESBURG
KAHOKA PUBLIC WORKS	WAYLAND PWS

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
KANSAS CITY PWS	BELTON PWS
	BIRMINGHAM VILLAGE OF PWS
	BLUE SPRINGS PWS
	CASS COUNTY PWSD 10
	CASS COUNTY PWSD 2
	CASS COUNTY PWSD 3
	CASS COUNTY PWSD 6
	CLAY COUNTY PWSD 2
	CLAY COUNTY PWSD 5
	CLAY COUNTY PWSD 6
	CLAY COUNTY PWSD 8
	CLAY COUNTY PWSD 9
	DEARBORN PWS
	FERRELVIEW PWS
	JACKSON COUNTY PWSD 1
	JACKSON COUNTY PWSD 12
	JACKSON COUNTY PWSD 2
	KEARNEY PWS
	LATHROP PWS
	LEES SUMMIT PWS
	NORTHMOOR PWS
	PLATTE CITY PWS
	PLATTE COUNTY CONS PWSD 1
	PLATTE COUNTY PWSD 2
	PLATTE COUNTY PWSD 4
	PLATTE COUNTY PWSD 9
	PLEASANT HILL PWS
	RAYMORE PWS
	RAYTOWN WATER COMPANY
	WEATHERBY LAKE PWS

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
KEYTESVILLE PWS	CHARITON COUNTY PWSD 2
KIRKSVILLE PWS	ADAIR COUNTY PWSD 1
KNOX COUNTY PUBLIC WATER & SEWER DIST 1	MACON COUNTY PWSD 1
LA MONTE PWS	PETTIS/JOHNSON/SALINE PWSD 1
LAF/JO/SALINE COUNTY CONS PWSD 2	PETTIS/JOHNSON/SALINE PWSD 1
	SWEET SPRINGS PWS
LAFAYETTE COUNTY PWSD 1	BALLERINA PARK HOME COMMUNITY
	BATES CITY PWS
	I 70 MOBILE CITY MHP
	LAKE LAFAYETTE PWS
	WELLINGTON PWS
LANCASTER PWS	GLENWOOD PWS
LEWIS COUNTY PWSD 1	MARION COUNTY PWSD 1
LEXINGTON PWS	LAF/JO/SALINE COUNTY CONS PWSD 2
LIBERTY PWS	CLAY COUNTY PWSD 4
LILBOURN PWS	NEW MADRID COUNTY PWSD 1
LINCOLN COUNTY PWSD 1	WINFIELD PWS
LINN LIVINGSTON COUNTY PWSD 3	LAREDO PWS
	LINNEUS PWS
	WHEELING PWS
LIVINGSTON COUNTY PWSD 2	CHULA PWS
LIVINGSTON COUNTY PWSD 3 EAST	HALE PWS

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
LIVINGSTON COUNTY PWSD 4	DAVIESS COUNTY PWSD 2
	HAMILTON PWS
	JAMESPORT PWS
LOUISIANA PWS	PIKE COUNTY PWSD 1
MACON COUNTY PWSD 1	CALLAO PWS
	CLARENCE PWS
	ELMER PWS
MACON PWS	ATLANTA PWS
	BEVIER PWS
	MACON COUNTY PWSD 1
MARCELINE PWS	CHARITON LINN COUNTY PWSD 3
MARSHALL PWS	LAF/JO/SALINE COUNTY CONS PWSD 2
	MALTA BEND PWS
	SALINE COUNTY PWSD 1
	SALINE COUNTY PWSD 3
	WAVERLY PWS
MARYVILLE PWS	NODAWAY COUNTY PWSD 1
MATTHEWS PWS	NEW MADRID COUNTY PWSD # 6
	NEW MADRID COUNTY PWSD 4
MIDDLE FORK WATER CO	GRANT CITY PWS
	STANBERRY PWS
MILL SPRING PWS	WAYNE COUNTY PWSD 3
MO AMERICAN BRUNSWICK	CHARITON COUNTY PWSD 2
MO AMERICAN MEXICO	AUDRAIN COUNTY PWSD 1
	AUDRAIN COUNTY PWSD 2

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
MO AMERICAN PLATTE COUNTY	LAKE WAUKOMIS PWS
	PLATTE COUNTY PWSD 6
MO AMERICAN ST JOSEPH	ANDREW COUNTY PWSD 1
	ANDREW COUNTY PWSD 2
	BUCHANAN COUNTY PWSD 1
	DEKALB COUNTY PWSD 1
	ELWOOD KANSAS
MO AMERICAN ST LOUIS ST CHARLES COUNTIES	JEFFERSON COUNTY CONS PWSD C 1
	JEFFERSON COUNTY PWSD 1
	JEFFERSON COUNTY PWSD 10
	JEFFERSON COUNTY PWSD 3
	KIRKWOOD PWS
MO AMERICAN WARRENSBURG	JOHNSON COUNTY PWSD 1
	PEMBROOKE PARK
MONROE CITY PWS	CANNON PWSD 1
MONTGOMERY CITY PWS	MONTGOMERY COUNTY PWSD 1 MONTGOMERY CITY
MOREHOUSE PWS	STODDARD COUNTY PWSD 3
MOUND CITY PWS	HOLT COUNTY PWSD 1
NEW MADRID PWS	NEW MADRID COUNTY PWSD 2
NODAWAY COUNTY PWSD 1	BARNARD PWS
	CLEARMONT PWS
NORTH CENTRAL MO REGIONAL WATER COM	GREEN CITY PWS
	MILAN PWS
	SULLIVAN COUNTY PWSD 1
OFALLON PWS	SUNEDISON SEMICONDUCTOR

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
OZARK PWS	MO AMERICAN SPRING VALLEY ESTATES SUB
PALMYRA PWS	MARION COUNTY PWSD 1
PATTONSBURG PWS	DAVIESS COUNTY PWSD 1
PEMISCOT COUNTY CON PWSD 1	COOTER PWS
PERRYVILLE PWS	PERRY COUNTY PWSD 2
PIKE COUNTY PWSD 1	FRANKFORD PWS
PILOT KNOB PWS	PILOT KNOB RURAL WD 1 N & S
PLATTE CITY PWS	PLATTE COUNTY PWSD 4
PLATTE COUNTY PWSD 9	TRACY PWS
PLATTSBURG PWS	CLINTON COUNTY PWSD 1
	CLINTON COUNTY PWSD 4 SYS 1
	CLINTON COUNTY PWSD 4 SYS 2
	EDGERTON PWS
PLEASANT HILL PWS	CASS COUNTY PWSD 1
POTOSI PWS	WASHINGTON COUNTY PWSD 1
PRATHERSVILLE PWS	MOSBY PWS
PRINCETON PWS	MERCER COUNTY PWSD 1
	MERCER PWS
PUBLIC WHOLESALE WATER SUPPLY DIST #13	HUME PWS
PUTNAM COUNTY PWSD 1	LAKE THUNDERHEAD
PWSD 2 OF HICKORY CO	POMME DE VILLA SUBDIVISION

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
RATHBUN REGIONAL WATER ASSOCIATION	LANCASTER PWS
	MERCER COUNTY PWSD 1
	PUTNAM COUNTY PWSD 1
	SCHUYLER COUNTY CONSOLIDATED PWSD 1
	SCOTLAND COUNTY CONS PWSD 1
RAVENWOOD PWS	NODAWAY COUNTY PWSD 1
RAY COUNTY CONS PWSD 2	HARDIN PWS
	ORRICK PWS
	RAY COUNTY PWSD 3
	WOOD HEIGHTS PWS
RAY COUNTY PWSD 3	POLO PWS
RICH HILL PWS	BATES COUNTY PWSD 4
RICHLAND PWS	PULASKI COUNTY PWSD 1
RICHMOND PWS	HENRIETTA PWS
RIPLEY COUNTY PWSD 2	NAYLOR PWS
ROCK PORT PWS	ATCHISON COUNTY PWSD 1
SALINE COUNTY PWSD 2	ARROW ROCK PWS
SALINE COUNTY PWSD 3	BLACKWATER PWS
	MIAMI PWS
	NELSON PWS
SAVANNAH PWS	ANDREW COUNTY PWSD 3
	TRIPLE L TRAILER PARK
SCHUYLER COUNTY CONSOLIDATED PWSD 1	ADAIR COUNTY PWSD 1
	DOWNING PWS

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
SEDALIA PWS	PETTIS/JOHNSON/SALINE PWSD 1
SHELBY COUNTY PWSD 1	HUNNEWELL PWS
SIKESTON PWS	SCOTT COUNTY PWSD 1
	SCOTT COUNTY PWSD 2
	SCOTT COUNTY PWSD 3
SLATER PWS	GILLIAM PWS
	SALINE COUNTY PWSD 2
SMITHVILLE PWS	PLATTE COUNTY PWSD 8
SOUTHERN IOWA RURAL WATER ASSOCIATION	WORTH COUNTY PWSD 1
ST CHARLES COUNTY PWSD 2	OFALLON PWS
	WENTZVILLE PWS
ST LOUIS CITY PWS	ST CHARLES COUNTY PWSD 2
	ST CHARLES PWS
	ST PETERS PWS
STANBERRY PWS	GENTRY COUNTY PWSD 2
STE GENEVIEVE COUNTY PWSD 1 SC	ST MARY PWS
STEELE PWS	HOLLAND PWS
STODDARD COUNTY PWSD 1	STODDARD COUNTY PWSD 4
SULLIVAN COUNTY PWSD 1	BROWNING PWS
	HUMPHREYS PWS
	NEWTOWN PWS
SWEET SPRINGS PWS	PETTIS/JOHNSON/SALINE PWSD 1
SWRWD CLARINDA	ELMO PWS

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
SWRWD RED OAK	WESTBORO PWS
THOMAS HILL PWSD 1	HIGBEE PWS
TRENTON MUNICIPAL UTILITIES	GRUNDY COUNTY PWSD 1
TRI COUNTY WATER AUTHORITY	BLUE SPRINGS PWS
	CASS BATES COUNTY PWSD 12
	CASS COUNTY PWSD 11
	CASS COUNTY PWSD 4
	CASS COUNTY PWSD 5
	CASS COUNTY PWSD 9
	DREXEL PWS
	EAST LYNNE PWS
	GRAIN VALLEY PWS
	JACKSON COUNTY PWSD 12
	JACKSON COUNTY PWSD 13
	JACKSON COUNTY PWSD 17
	LAKE WINNEBAGO PWS
	PLEASANT HILL PWS
TROY PWS	LINCOLN COUNTY PWSD 2
UNIONVILLE PWS	PUTNAM COUNTY PWSD 1
VAN BUREN PWS	DEER RUN SUBD
VERNON COUNTY CONS PWSD 1	SCHELL CITY PWS
WARSAW PWS	BRADEN PARK VILLAGE
WAVERLY PWS	LAF/JO/SALINE COUNTY CONS PWSD 2
WAYNE COUNTY PWSD 3	USACE CLEARWATER RIVER RD LEFT BK 10

Water Systems that Sell Water to Other Water Systems

SYSTEMS THAT SELL WATER	SYSTEMS THEY SELL WATER TO
WESTON PWS	PLATTE COUNTY PWSD 3
	PLATTE COUNTY PWSD 7

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
ADAIR COUNTY PWSD 1	KIRKSVILLE PWS
	SCHUYLER COUNTY CONSOLIDATED PWSD 1
ALMA PWS	CORDER PWS
ALTAMONT PWS	DAVIESS COUNTY PWSD 1
AMAZONIA PWS	ANDREW COUNTY PWSD 1
AMORET PWS	BATES COUNTY PWSD 2
ANDREW COUNTY PWSD 1	MO AMERICAN ST JOSEPH
ANDREW COUNTY PWSD 2	ANDREW COUNTY PWSD 4
	MO AMERICAN ST JOSEPH
ANDREW COUNTY PWSD 3	SAVANNAH PWS
ANDREW COUNTY PWSD 4	BOLCKOW PWS
ANNISTON PWS	EAST PRAIRIE PWS
APPLETON CITY PWS	HARRY S TRUMAN PWSD 2
ARROW ROCK PWS	SALINE COUNTY PWSD 2
ATCHISON COUNTY PWSD 1	ROCK PORT PWS
ATLANTA PWS	MACON PWS
AUDRAIN COUNTY PWSD 1	MO AMERICAN MEXICO
AUDRAIN COUNTY PWSD 2	MO AMERICAN MEXICO
BALLERINA PARK HOME COMMUNITY	LAFAYETTE COUNTY PWSD 1
BARNARD PWS	NODAWAY COUNTY PWSD 1
BATES CITY PWS	LAFAYETTE COUNTY PWSD 1
BATES COUNTY PWSD 1	BUTLER PWS

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
BATES COUNTY PWSD 3	BUTLER PWS
BATES COUNTY PWSD 4	BATES COUNTY PWSD 2
	BUTLER PWS
	RICH HILL PWS
BATES COUNTY PWSD 5	ADRIAN PWS
BATES COUNTY PWSD 6	BUTLER PWS
	HARRY S TRUMAN PWSD 2
BATES COUNTY PWSD 7	HARRY S TRUMAN PWSD 2
BELTON PWS	KANSAS CITY PWS
BEVIER PWS	MACON PWS
BIG LAKE VILLAGE OF PWS	CRAIG PWS
BIRMINGHAM VILLAGE OF PWS	KANSAS CITY PWS
BLACKWATER PWS	SALINE COUNTY PWSD 3
BLAIRSTOWN PWS	HENRY COUNTY PWSD 4
BLUE ACRES MHP	COLUMBIA PWS
BLUE SPRINGS PWS	INDEPENDENCE PWS
	KANSAS CITY PWS
	TRI COUNTY WATER AUTHORITY
BOGARD PWS	CARROLL COUNTY PWSD 1
BOWLING GREEN PWS	CLARENCE CANNON WHOLESALE WTR COMM
BRADEN PARK VILLAGE	WARSAW PWS
BRASHEAR PWS	ADAIR COUNTY PWSD 1
BRECKENRIDGE PWS	DAVIESS COUNTY PWSD 2

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
BROWNING PWS	SULLIVAN COUNTY PWSD 1
BUCHANAN COUNTY PWSD 1	MO AMERICAN ST JOSEPH
BUCKLIN PWS	CHARITON LINN COUNTY PWSD 3
BUCKNER PWS	INDEPENDENCE PWS
BUTLER COUNTY PWSD 104	FISK PWS
CAINSVILLE PWS	HARRISON COUNTY PWSD 2
CALDWELL COUNTY PWSD 2	HAMILTON PWS
CALDWELL COUNTY PWSD 3	CLINTON COUNTY PWSD 4 SYS 1
CALHOUN PWS	HENRY COUNTY PWSD 3
CALLAO PWS	MACON COUNTY PWSD 1
CANNON PWSD 1	CLARENCE CANNON WHOLESALE WTR COMM
	MONROE CITY PWS
CASS BATES COUNTY PWSD 12	TRI COUNTY WATER AUTHORITY
CASS COUNTY PWSD 1	PLEASANT HILL PWS
CASS COUNTY PWSD 10	KANSAS CITY PWS
CASS COUNTY PWSD 11	TRI COUNTY WATER AUTHORITY
CASS COUNTY PWSD 2	KANSAS CITY PWS
CASS COUNTY PWSD 3	KANSAS CITY PWS
CASS COUNTY PWSD 4	TRI COUNTY WATER AUTHORITY
CASS COUNTY PWSD 5	TRI COUNTY WATER AUTHORITY
CASS COUNTY PWSD 6	KANSAS CITY PWS

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
CASS COUNTY PWSD 8	BELTON PWS
CASS COUNTY PWSD 9	CASS COUNTY PWSD 4
	TRI COUNTY WATER AUTHORITY
CENTERVIEW PWS	JOHNSON COUNTY PWSD 1
CHARITON COUNTY PWSD 2	CHARITON LINN COUNTY PWSD 3
	KEYTESVILLE PWS
	MO AMERICAN BRUNSWICK
CHARITON LINN COUNTY PWSD 3	BROOKFIELD PWS
	MARCELINE PWS
CHILHOWEE PWS	JOHNSON COUNTY PWSD 2
CHULA PWS	LIVINGSTON COUNTY PWSD 2
CLARENCE PWS	CLARENCE CANNON WHOLESALE WTR COMM
	MACON COUNTY PWSD 1
CLARK PWS	BOONE COUNTY PWSD 10
CLARKSDALE PWS	DEKALB COUNTY PWSD 1
CLAY COUNTY PWSD 2	KANSAS CITY PWS
CLAY COUNTY PWSD 3	EXCELSIOR SPRINGS PWS
CLAY COUNTY PWSD 4	LIBERTY PWS
CLAY COUNTY PWSD 5	KANSAS CITY PWS
CLAY COUNTY PWSD 6	KANSAS CITY PWS
CLAY COUNTY PWSD 7	CLAY COUNTY PWSD 4
CLAY COUNTY PWSD 8	KANSAS CITY PWS
CLAY COUNTY PWSD 9	KANSAS CITY PWS

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
CLEARMONT PWS	NODAWAY COUNTY PWSD 1
CLEVELAND PWS	CASS COUNTY PWSD 2
CLINTON COUNTY PWSD 1	PLATTSBURG PWS
CLINTON COUNTY PWSD 3	CAMERON PWS
	CLINTON COUNTY PWSD 4 SYS 1
CLINTON COUNTY PWSD 4 SYS 1	CLINTON COUNTY PWSD 4 SYS 2
	PLATTSBURG PWS
CLINTON COUNTY PWSD 4 SYS 2	PLATTSBURG PWS
COFFEY PWS	HARRISON COUNTY PWSD 2
COOPER COUNTY CONSOLIDATED PWSD # 1	BOONVILLE PWS
COOTER PWS	PEMISCOT COUNTY CON PWSD 1
CORDER PWS	HIGGINSVILLE PWS
CREIGHTON PWS	CASS COUNTY PWSD 11
CROWN MOBILE HOME PARK	BELTON PWS
CURRYVILLE PWS	CLARENCE CANNON WHOLESALE WTR COMM
DAVIESS COUNTY PWSD 1	PATTONSBURG PWS
DAVIESS COUNTY PWSD 2	GALLATIN PWS
	HARRISON COUNTY PWSD 2
	LIVINGSTON COUNTY PWSD 4
DEARBORN PWS	KANSAS CITY PWS
DEEPWATER PWS	HARRY S TRUMAN PWSD 2
DEER RUN SUBD	VAN BUREN PWS

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
DEKALB COUNTY PWSD 1	ANDREW COUNTY PWSD 2
	MO AMERICAN ST JOSEPH
DEKALB PWS	BUCHANAN COUNTY PWSD 1
DEWITT PWS	CARROLL COUNTY PWSD 1
DOWNING PWS	SCHUYLER COUNTY CONSOLIDATED PWSD 1
DREXEL PWS	TRI COUNTY WATER AUTHORITY
DUNKLIN COUNTY PWSD 3 NORTH	HOLCOMB PWS
EAST LYNNE PWS	TRI COUNTY WATER AUTHORITY
EASTON PWS	DEKALB COUNTY PWSD 1
EDGERTON PWS	PLATTSBURG PWS
EDINA PWS	CLARENCE CANNON WHOLESALE WTR COMM
ELMER PWS	MACON COUNTY PWSD 1
ELMO PWS	SWRWD CLARINDA
ELWOOD KANSAS	MO AMERICAN ST JOSEPH
EMMA PWS	CONCORDIA PWS
FAIRFAX PWS	ATCHISON COUNT WHOLESALE WATER COMMISSIO
FARBER PWS	CLARENCE CANNON WHOLESALE WTR COMM
FERRELVIEW PWS	KANSAS CITY PWS
FESTUS PWS	JEFFERSON COUNTY WATER AUTHORITY
FILLMORE PWS	ANDREW COUNTY PWSD 3
FRANKFORD PWS	PIKE COUNTY PWSD 1

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
FREEMAN PWS	CASS COUNTY PWSD 7
GALT PWS	GRUNDY COUNTY PWSD 1
GENTRY COUNTY PWSD 1	ALBANY PWS
GENTRY COUNTY PWSD 2	STANBERRY PWS
GILLIAM PWS	SLATER PWS
GILMAN CITY PWS	HARRISON COUNTY PWSD 2
GLENWOOD PWS	LANCASTER PWS
GOWER PWS	DEKALB COUNTY PWSD 1
GRAIN VALLEY PWS	INDEPENDENCE PWS
	TRI COUNTY WATER AUTHORITY
GRANT CITY PWS	MIDDLE FORK WATER CO
GREEN CASTLE PWS	GREEN CITY PWS
GREEN CITY PWS	NORTH CENTRAL MO REGIONAL WATER COM
GREEN HILLS MHP	BOONE COUNTY CONS PWSD 1
GRUNDY COUNTY PWSD 1	TRENTON MUNICIPAL UTILITIES
HALE PWS	LIVINGSTON COUNTY PWSD 3 EAST
HALLSVILLE PWS	BOONE COUNTY PWSD 4
HAMILTON PWS	DAVIESS COUNTY PWSD 2
	LIVINGSTON COUNTY PWSD 4
HARDIN PWS	RAY COUNTY CONS PWSD 2
HARRISBURG PWS	BOONE COUNTY CONS PWSD 1
HARRISON COUNTY PWSD 1	HARRISON COUNTY PWSD 2

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
HENRIETTA PWS	RICHMOND PWS
HENRY COUNTY PWSD 1	HARRY S TRUMAN PWSD 2
HENRY COUNTY PWSD 3	HENRY COUNTY WATER COMPANY
HENRY COUNTY PWSD 4	HENRY COUNTY PWSD 3
HERCULANEUM PWS	JEFFERSON COUNTY WATER AUTHORITY
HIGBEE PWS	THOMAS HILL PWSD 1
HIGHLAND MANOR	INDEPENDENCE PWS
HOLLAND PWS	STEELE PWS
HOLT COUNTY PWSD 1	CRAIG PWS
	MOUND CITY PWS
HOWARD COUNTY PWSD 2	GLASGOW PWS
HUME PWS	PUBLIC WHOLESALE WATER SUPPLY DIST #13
HUMPHREYS PWS	SULLIVAN COUNTY PWSD 1
HUNNEWELL PWS	SHELBY COUNTY PWSD 1
HUNTSVILLE PWS	CLARENCE CANNON WHOLESALE WTR COMM
I 70 MOBILE CITY MHP	LAFAYETTE COUNTY PWSD 1
JACKSON COUNTY PWSD 1	KANSAS CITY PWS
JACKSON COUNTY PWSD 12	KANSAS CITY PWS
	TRI COUNTY WATER AUTHORITY
JACKSON COUNTY PWSD 13	TRI COUNTY WATER AUTHORITY
JACKSON COUNTY PWSD 15	INDEPENDENCE PWS
JACKSON COUNTY PWSD 16	INDEPENDENCE PWS

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
JACKSON COUNTY PWSD 17	INDEPENDENCE PWS
	TRI COUNTY WATER AUTHORITY
JACKSON COUNTY PWSD 2	INDEPENDENCE PWS
	KANSAS CITY PWS
JAMESPORT PWS	LIVINGSTON COUNTY PWSD 4
JASPER COUNTY PWSD 3	CARTERVILLE PWS
	DUENWEG PWS
JEFFERSON COUNTY CONS PWSD C 1	MO AMERICAN ST LOUIS ST CHARLES COUNTIES
JEFFERSON COUNTY PWSD 1	MO AMERICAN ST LOUIS ST CHARLES COUNTIES
JEFFERSON COUNTY PWSD 10	MO AMERICAN ST LOUIS ST CHARLES COUNTIES
JEFFERSON COUNTY PWSD 3	MO AMERICAN ST LOUIS ST CHARLES COUNTIES
JOHNSON COUNTY PWSD 1	MO AMERICAN WARRENSBURG
KEARNEY PWS	KANSAS CITY PWS
KINGSVILLE PWS	JOHNSON COUNTY PWSD 2
KIRKWOOD PWS	MO AMERICAN ST LOUIS ST CHARLES COUNTIES
KNOX COUNTY PUBLIC WATER & SEWER DIST 1	CLARENCE CANNON WHOLESALE WTR COMM
LA BELLE PWS	CLARENCE CANNON WHOLESALE WTR COMM
LACLEDE PWS	BROOKFIELD PWS

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
LAF/JO/SALINE COUNTY CONS PWSD 2	CONCORDIA PWS
	CORDER PWS
	HIGGINSVILLE PWS
	LEXINGTON PWS
	MARSHALL PWS
	WAVERLY PWS
LAFAYETTE COUNTY PWSD 1	INDEPENDENCE PWS
LAKE LAFAYETTE PWS	LAFAYETTE COUNTY PWSD 1
LAKE TAPAWINGO PWS	INDEPENDENCE PWS
LAKE THUNDERHEAD	PUTNAM COUNTY PWSD 1
LAKE WAUKOMIS PWS	MO AMERICAN PLATTE COUNTY
LAKE WINNEBAGO PWS	TRI COUNTY WATER AUTHORITY
LANCASTER PWS	RATHBUN REGIONAL WATER ASSOCIATION
LAPLATA PWS	ADAIR COUNTY PWSD 1
LAREDO PWS	LINN LIVINGSTON COUNTY PWSD 3
LATHROP PWS	KANSAS CITY PWS
LAWSON PWS	EXCELSIOR SPRINGS PWS
LEES SUMMIT PWS	INDEPENDENCE PWS
	KANSAS CITY PWS
LEVASY PWS	BUCKNER PWS
LEWIS COUNTY PWSD 1	CLARENCE CANNON WHOLESALE WTR COMM
LEWISTOWN PWS	CLARENCE CANNON WHOLESALE WTR COMM
LINCOLN COUNTY PWSD 2	TROY PWS

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
LINNEUS PWS	LINN LIVINGSTON COUNTY PWSD 3
LIVINGSTON COUNTY PWSD 1	CHILLICOTHE MUNICIPAL UTILITIES
LIVINGSTON COUNTY PWSD 2	CHILLICOTHE MUNICIPAL UTILITIES
LIVINGSTON COUNTY PWSD 3 EAST	CHILLICOTHE MUNICIPAL UTILITIES
MACON COUNTY PWSD 1	ADAIR COUNTY PWSD 1
	CLARENCE CANNON WHOLESALE WTR COMM
	KNOX COUNTY PUBLIC WATER & SEWER DIST 1
	MACON PWS
MADISON PWS	CLARENCE CANNON WHOLESALE WTR COMM
MALTA BEND PWS	MARSHALL PWS
MARION COUNTY PWSD 1	CLARENCE CANNON WHOLESALE WTR COMM
	LEWIS COUNTY PWSD 1
	PALMYRA PWS
MAYVIEW PWS	HIGGINSVILLE PWS
MENDON PWS	CHARITON LINN COUNTY PWSD 3
MERCER COUNTY PWSD 1	PRINCETON PWS
	RATHBUN REGIONAL WATER ASSOCIATION
MERCER PWS	PRINCETON PWS
MIAMI PWS	SALINE COUNTY PWSD 3
MILAN PWS	NORTH CENTRAL MO REGIONAL WATER COM
MISSISSIPPI COUNTY PWSD 1	CHARLESTON PWS
	EAST PRAIRIE PWS
MISSOURI CITY PWS	CLAY COUNTY PWSD 4

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
MO AMERICAN JEFFERSON CITY NORTH	CALLAWAY COUNTY PWSD 1
MO AMERICAN SPRING VALLEY ESTATES SUB	OZARK PWS
MONROE COUNTY PWSD 2	CLARENCE CANNON WHOLESALE WTR COMM
MONTGOMERY COUNTY PWSD 1 JONESBURG	JONESBURG PWS
MONTGOMERY COUNTY PWSD 1 MONTGOMERY CITY	MONTGOMERY CITY PWS
MONTROSE PWS	HARRY S TRUMAN PWSD 2
MOSBY PWS	PRATHERSVILLE PWS
NAYLOR PWS	RIPLEY COUNTY PWSD 2
NEELYVILLE PWS	BUTLER COUNTY PWSD 1
NELSON PWS	SALINE COUNTY PWSD 3
NEW CHRISTIAN LIFE FELLOWSHIP	CALLAWAY 2 WATER DISTRICT
NEW HAMPTON PWS	GENTRY COUNTY PWSD 1
NEW LONDON PWS	CLARENCE CANNON WHOLESALE WTR COMM
NEW MADRID COUNTY PWSD # 6	MATTHEWS PWS
NEW MADRID COUNTY PWSD 1	LILBOURN PWS
NEW MADRID COUNTY PWSD 2	NEW MADRID PWS
NEW MADRID COUNTY PWSD 4	MATTHEWS PWS
NEWTOWN PWS	SULLIVAN COUNTY PWSD 1
NODAWAY COUNTY PWSD 1	MARYVILLE PWS
	RAVENWOOD PWS
NORTHMOOR PWS	KANSAS CITY PWS

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
NOVINGER PWS	ADAIR COUNTY PWSD 1
NW CASS COUNTY SEWER & WATER DISTRICT	BELTON PWS
OAK GROVE PWS	INDEPENDENCE PWS
OFALLON PWS	ST CHARLES COUNTY PWSD 2
ORRICK PWS	RAY COUNTY CONS PWSD 2
PARIS PWS	CLARENCE CANNON WHOLESALE WTR COMM
PARNELL PWS	GRANT CITY PWS
PECULIAR PWS	CASS COUNTY PWSD 2
PEMBROOKE PARK	MO AMERICAN WARRENSBURG
PERRY COUNTY PWSD 2	PERRYVILLE PWS
PERRY PWS	CLARENCE CANNON WHOLESALE WTR COMM
PETTIS/JOHNSON/SALINE PWSD 1	EMMA PWS
	LA MONTE PWS
	LAF/JO/SALINE COUNTY CONS PWSD 2
	SEDALIA PWS
	SWEET SPRINGS PWS
PICKERING PLACE	CASS COUNTY PWSD 2
PIKE COUNTY PWSD 1	CLARENCE CANNON WHOLESALE WTR COMM
	LOUISIANA PWS
PILOT KNOB RURAL WD 1 N & S	PILOT KNOB PWS
PLATTE CITY PWS	KANSAS CITY PWS
PLATTE COUNTY CONS PWSD 1	KANSAS CITY PWS
PLATTE COUNTY PWSD 2	KANSAS CITY PWS

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
PLATTE COUNTY PWSD 3	WESTON PWS
PLATTE COUNTY PWSD 4	KANSAS CITY PWS
	PLATTE CITY PWS
PLATTE COUNTY PWSD 6	MO AMERICAN PLATTE COUNTY
PLATTE COUNTY PWSD 7	WESTON PWS
PLATTE COUNTY PWSD 8	SMITHVILLE PWS
PLATTE COUNTY PWSD 9	KANSAS CITY PWS
PLEASANT HILL PWS	KANSAS CITY PWS
	TRI COUNTY WATER AUTHORITY
POLO PWS	RAY COUNTY PWSD 3
POMME DE VILLA SUBDIVISION	PWSD 2 OF HICKORY CO
PRATHERSVILLE PWS	EXCELSIOR SPRINGS PWS
PULASKI COUNTY PWSD 1	RICHLAND PWS
PULASKI COUNTY PWSD 3	DIXON PWS
PUTNAM COUNTY PWSD 1	RATHBUN REGIONAL WATER ASSOCIATION
	UNIONVILLE PWS
QUAIL RUN OF IMPERIAL	JEFFERSON COUNTY CONS PWSD C 1
RALLS COUNTY PWSD 1	HANNIBAL PWS
RAY COUNTY PWSD 1	EXCELSIOR SPRINGS PWS
RAY COUNTY PWSD 3	RAY COUNTY CONS PWSD 2
RAYMORE PWS	KANSAS CITY PWS
RAYTOWN WATER COMPANY	KANSAS CITY PWS

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
RIDGEWAY PWS	HARRISON COUNTY PWSD 2
ROCK PORT PWS	ATCHISON COUNT WHOLESALE WATER COMMISSIO
ROCKVILLE PWS	HARRY S TRUMAN PWSD 2
ROSENDALE PWS	ANDREW COUNTY PWSD 4
SALINE COUNTY PWSD 1	MARSHALL PWS
SALINE COUNTY PWSD 2	SLATER PWS
SALINE COUNTY PWSD 3	MARSHALL PWS
SCHELL CITY PWS	VERNON COUNTY CONS PWSD 1
SCHUYLER COUNTY CONSOLIDATED PWSD 1	RATHBUN REGIONAL WATER ASSOCIATION
SCOTLAND COUNTY CONS PWSD 1	RATHBUN REGIONAL WATER ASSOCIATION
SCOTT COUNTY PWSD 1	SIKESTON PWS
SCOTT COUNTY PWSD 2	SIKESTON PWS
SCOTT COUNTY PWSD 3	SIKESTON PWS
SEGES MOBILE HOME PARK	CALLAWAY COUNTY PWSD 1
SHELBY COUNTY PWSD 1	CLARENCE CANNON WHOLESALE WTR COMM
SHELBYVILLE PWS	CLARENCE CANNON WHOLESALE WTR COMM
SIBLEY PWS	BUCKNER PWS
SOUTHFORK MHP	BELTON PWS
SPICKARD PWS	GRUNDY COUNTY PWSD 1
ST CHARLES COUNTY PWSD 2	ST LOUIS CITY PWS
ST CHARLES PWS	ST LOUIS CITY PWS

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
ST MARY PWS	STE GENEVIEVE COUNTY PWSD 1 SC
ST PETERS PWS	ST LOUIS CITY PWS
STANBERRY PWS	MIDDLE FORK WATER CO
STEWARTSVILLE PWS	DEKALB COUNTY PWSD 1
STODDARD COUNTY PWSD 3	MOREHOUSE PWS
STODDARD COUNTY PWSD 4	STODDARD COUNTY PWSD 1
STODDARD COUNTY PWSD 5	BLOOMFIELD PWS
STODDARD COUNTY PWSD 6	BERNIE PWS
STODDARD COUNTY PWSD 7	BERNIE PWS
STURGEON PWS	BOONE COUNTY PWSD 10
SUGAR CREEK ESTATES MHP	JEFFERSON COUNTY PWSD 2
SUGAR CREEK PWS	INDEPENDENCE PWS
SULLIVAN COUNTY PWSD 1	NORTH CENTRAL MO REGIONAL WATER COM
SUNEDISON SEMICONDUCTOR	OFALLON PWS
SWEET SPRINGS PWS	LAF/JO/SALINE COUNTY CONS PWSD 2
TARKIO BOARD OF PUBLIC WORKS	ATCHISON COUNT WHOLESALE WATER COMMISSIO
THOMAS HILL PWSD 1	CLARENCE CANNON WHOLESALE WTR COMM
TINA PWS	CARROLL COUNTY PWSD 1
TRACY PWS	PLATTE COUNTY PWSD 9
TRIPLE L TRAILER PARK	SAVANNAH PWS
UNION STAR PWS	ANDREW COUNTY PWSD 2

Water Systems that Buy Water from Other Water Systems

SYSTEMS THAT BUY WATER	SYSTEMS THEY BUY WATER FROM
URICH PWS	HENRY COUNTY PWSD 4
USACE CLEARWATER RIVER RD LEFT BK 10	WAYNE COUNTY PWSD 3
VERNON COUNTY PWSD 7	BOURBON CO RWD 2C
	FORT SCOTT
WASHINGTON COUNTY PWSD 1	POTOSI PWS
WAVERLY PWS	MARSHALL PWS
WAYLAND PWS	KAHOKA PUBLIC WORKS
WAYNE COUNTY PWSD 3	MILL SPRING PWS
WEATHERBY LAKE PWS	KANSAS CITY PWS
WELLINGTON PWS	LAFAYETTE COUNTY PWSD 1
WELLSVILLE PWS	CLARENCE CANNON WHOLESALE WTR COMM
WENTZVILLE PWS	ST CHARLES COUNTY PWSD 2
WESTBORO PWS	SWRWD RED OAK
WHEELING PWS	LINN LIVINGSTON COUNTY PWSD 3
WINFIELD PWS	LINCOLN COUNTY PWSD 1
WOOD HEIGHTS PWS	RAY COUNTY CONS PWSD 2
WORTH COUNTY PWSD 1	SOUTHERN IOWA RURAL WATER ASSOCIATION
WYACONDA PWS	CLARK COUNTY CONS PWSD 1

IV. NONCOMMUNITY WATER SYSTEM INVENTORY INFORMATION

NONCOMMUNITY WATER SYSTEM INVENTORY INFORMATION
INTRODUCTION

The Noncommunity Water System Inventory Information section contains data on noncommunity public water systems regulated by the Missouri Department of Natural Resources' Water Protection Program, Public Drinking Water Branch. There are two types of noncommunity public water systems. One type of noncommunity public water system is a transient noncommunity public water system. This is a public water system that is not a community water system, which has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year (Missouri Safe Drinking Water Regulations 10 CSR 60-2.015). This means that for the most part, the population changes daily. These systems include, but are not limited to, recreational areas, restaurants, highway rest areas, hotel/motels, campgrounds, etc. The second type of noncommunity public water system is a nontransient noncommunity public water system. This is a public water system that is not a community water system and that regularly serves at least 25 of the same persons over six months per year (Missouri Safe Drinking Water Regulations 10 CSR 60-2.015). This means that for the most part, the same population returns daily to the facility. These systems include, but are not limited to, factories, large businesses and industries, schools, etc.

Noncommunity Water System Inventory Information contains a complete listing of active noncommunity water systems. This list contains the system name, county of location, system identification number, system type and season begin and end dates. The noncommunity listing is first by county and then alphabetical within the county.

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
BARRY	ABC WATER ASSN	MO5252577	25	OTHER RESIDENTIAL AREA	1 /1	12/31
	AIRPARK BEACH	MO5031627	42	OTHER TRANSIENT AREA	1 /1	12/31
	BEREAN CHRISTIAN ACADEMY	MO5172958	145	SCHOOL	8 /1	5 /31
	BRANDY STATION	MO5282809	34	SECONDARY RESIDENCES	1 /1	12/31
	BRIDGEWAY PLAZA SHOPPING CENTER	MO5210659	125	RESTAURANT	1 /1	12/31
	CAMP BARNABAS	MO5202704	110	RECREATION AREA	6 /1	8 /31
	COUNTRY FRESH MARKET	MO5282971	35	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	COUNTRY VILLAGE MHP	MO5261623	25	MOBILE HOME PARK	1 /1	12/31
	DOLLAR GENERAL #14995	MO5283110	25	OTHER TRANSIENT AREA	1 /1	12/31
	DOLLAR GENERAL #15781	MO5283142	25	OTHER TRANSIENT AREA	1 /1	12/31
	DOLLAR GENERAL #4022	MO5283094	25	RETAIL EMPLOYEES	1 /1	12/31
	EAGLE ROCK MARINA	MO5233218	25	OTHER TRANSIENT AREA	3 /1	10/31
	FISHERMANS TABLE ROCK IMPRVMNT ASSN	MO5252511	30	SUBDIVISION	4 /1	9 /30
	FOX FITNESS 24	MO5203145	25	RECREATION AREA	1 /1	12/31
	FRATERNAL ORDER OF EAGLE 4155	MO5212841	30	RESTAURANT	1 /1	12/31
	GEORGES PROCESSING INC	MO5181388	1000	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	HOLY FAMILY CATHOLIC CHURCH	MO5272977	75	OTHER TRANSIENT AREA	1 /1	12/31
	KIDS ACROSS AMERICA	MO5248294	290	SUMMER CAMP	6 /1	8 /31
	KINGS HARBOR RESORT	MO5211301	50	HOTEL/MOTEL	4 /1	9 /30
	KINGS RIVER MARINA	MO5233074	100	OTHER TRANSIENT AREA	3 /1	9 /30
	KINGS VIEW SUBDIVISION	MO5258290	40	SUBDIVISION	1 /1	12/31
	LAKE POINT LANDING POA INC	MO5031625	40	OTHER TRANSIENT AREA	4 /1	9 /30
	LAZY EAGLE RESORT	MO5190895	25	HOTEL/MOTEL	1 /1	12/31
	MAYO BEACH SUBD	MO5252337	34	SUBDIVISION	1 /1	12/31
	MITCHELLS PLAZA	MO5210653	25	RESTAURANT	1 /1	12/31
	NEEDLES EYE BEACH	MO5031105	40	SUBDIVISION	1 /1	12/31
	NEW SITE BAPTIST CHURCH	MO5272961	500	OTHER TRANSIENT AREA	1 /1	12/31
	OFFICE PUB & STEAKHOUSE	MO5211851	190	RESTAURANT	1 /1	12/31
	PARADISE VALLEY CAMPING CLUB	MO5243077	84	OTHER TRANSIENT AREA	3 /1	10/31
	PIZZA HUT	MO5211850	150	RESTAURANT	1 /1	12/31
	RAPID ROBERTS 106	MO5291277	400	SERVICE STATION	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
BARRY	RIVERSIDE PARK 2ND ADD	MO5031106	25	SUBDIVISION	1 /1	12/31
	ROADHOUSE GRILL & PUB	MO5210631	25	RESTAURANT	1 /1	12/31
	ROARING RIVER STATE PARK	MO5120166	750	RECREATION AREA	1 /1	12/31
	ROD N REEL RESORT	MO5191567	35	HOTEL/MOTEL	4 /1	9 /30
	SANS SOUCI HOA	MO5031369	25	SECONDARY RESIDENCES	1 /1	12/31
	SHAWNEE WOODS SUBD	MO5250538	26	SUBDIVISION	1 /1	12/31
	SHELL KNOB ELEMENTARY SCHOOL	MO5171119	200	SCHOOL	1 /1	12/31
	SHORELINE CAMPGROUND AND RESORT	MO5241299	25	SUMMER CAMP	5 /1	10/31
	SHUMAKER TIRE COMPANY INC	MO5231302	50	SERVICE STATION	1 /1	12/31
	SUBWAY	MO5218155	25	RESTAURANT	1 /1	12/31
	TABLE ROCK VINEY CREEK 105	MO5111946	110	RECREATION AREA	5 /6	10/31
	TERRYS CAFE	MO5213090	25	RESTAURANT	1 /1	12/31
	THE STEAK INN	MO5218163	70	RESTAURANT	2 /1	12/31
	THE TIMBERS RESORT AND LODGE	MO5202810	75	RECREATION AREA	1 /1	12/31
	TIMBEROC VILLAGE SHOPPING CENTER	MO5211485	25	RESTAURANT	1 /1	12/31
	UNCLE ROYS ONE STOP	MO5291283	100	SERVICE STATION	1 /1	12/31
	USACE TABLE ROCK BIG M MARINA	MO5111949	100	RECREATION AREA	5 /1	9 /30
	USACE TABLE ROCK BIG M PARK	MO5112269	25	RECREATION AREA	5 /1	9 /30
	USACE TABLE ROCK EAGLE ROCK	MO5111948	175	RECREATION AREA	5 /1	9 /30
	USACE TABLE ROCK VIOLA PARK	MO5111947	100	RECREATION AREA	5 /1	9 /30
	VFW POST 4207	MO5282767	25	OTHER TRANSIENT AREA	1 /1	12/31
	VIOLA R V & MOBILE HOME PARK	MO5258287	35	SUBDIVISION	1 /1	12/31
	WOOD HAVEN SUBDIVISION	MO5031354	90	SECONDARY RESIDENCES	1 /1	12/31
	YONKERVILLE COUNTRY STORE	MO5291633	25	SERVICE STATION	1 /1	12/31
BENTON	3 D SALES LLC	MO1212952	25	RESTAURANT	1 /1	12/31
	ABUNDANT LIFE CHRISTIAN CHURCH	MO1272844	300	OTHER TRANSIENT AREA	1 /1	12/31
	ANGLERS CAMP	MO3241706	50	RECREATION AREA	1 /1	12/31
	ANGLERS RETREAT RV PARK	MO1242707	25	OTHER TRANSIENT AREA	3 /1	10/31
	ANGLERS RETREAT RV PARK ON MM HWY	MO1202765	63	RECREATION AREA	4 /1	10/31
	AUSTINS PLACE	MO1243176	25	OTHER TRANSIENT AREA	4 /1	10/31
	BB BAR & RESTAURANT	MO3210256	40	RESTAURANT	1 /1	12/31
	BENT TREE HARBOR	MO1293111	25	SERVICE STATION	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
BENTON	BUNKHOUSE LODGE	MO3192338	40	HOTEL/MOTEL	1 /1	12/31
	CEDAR GROVE BAPTIST CHURCH	MO3270289	25	OTHER TRANSIENT AREA	1 /1	12/31
	CHARLEYS BUFFET	MO1212915	250	RESTAURANT	3 /1	11/30
	CITY UNION MISSION	MO3240554	70	OTHER RESIDENTIAL AREA	1 /1	12/31
	CLEAR CREEK RV PARK	MO1242804	25	RECREATION AREA	1 /1	12/31
	DARS CAFE	MO3210344	25	RESTAURANT	1 /1	12/31
	DOLLAR GENERAL #16502 WARSAW	MO1283209	25	OTHER TRANSIENT AREA	1 /1	12/31
	DUBS DANCE CLUB	MO1212766	25	RESTAURANT	1 /1	12/31
	EAGLES NEST RV RESORT	MO3241430	25	RECREATION AREA	4 /1	11/30
	EDGEWATER RV PARK	MO3242467	100	RECREATION AREA	3 /1	11/30
	FORBES LOA RV PARK	MO1242798	25	RECREATION AREA	4 /15	11/30
	GRAND RIVER RESORT	MO3190267	150	HOTEL/MOTEL	4 /1	10/31
	HARRY S TRUMAN STATE PARK CAMPGRD	MO1122649	500	RECREATION AREA	4 /1	10/31
	HARRY S TRUMAN STATE PARK MARINA	MO1122648	58	RECREATION AREA	4 /1	10/31
	HARRY S TRUMAN STATE PARK OFFICE	MO3120156	94	RECREATION AREA	4 /1	10/31
	HEAD WATERS MOTEL	MO3190902	40	HOTEL/MOTEL	1 /1	12/31
	HEITS POINT LUTHERAN CAMP SYSTEM 1	MO3242078	60	RECREATION AREA	1 /1	12/31
	HIDDEN LAKE MOTEL	MO3190264	28	HOTEL/MOTEL	1 /1	12/31
	HILLTOP BAR B Q	MO3210326	30	RESTAURANT	1 /1	12/31
	HOT SPOT	MO3291407	25	OTHER TRANSIENT AREA	1 /1	12/31
	JAKS RV PARK	MO3241019	25	RECREATION AREA	5 /1	10/31
	JESTERS HOUSE	MO1212836	50	RESTAURANT	1 /1	12/31
	KIRN LAKEVIEW RV PARK	MO1262871	25	OTHER TRANSIENT AREA	4 /1	10/31
	KOLBS LAKESIDE RESORT LLC	MO3190082	120	HOTEL/MOTEL	1 /1	12/31
	LAKE HILLS MOTEL	MO3210904	30	HOTEL/MOTEL	3 /1	11/30
	LAKEVIEW HEIGHTS WATER ASSOCIATION INC	MO3036072	25	RESIDENTIAL AREA	1 /1	12/31
	LAKEVIEW RV	MO3242480	25	RECREATION AREA	4 /1	11/30
	LOST ACRES	MO1212806	25	RESTAURANT	1 /1	12/31
	LOST VALLEY HATCHERY	MO3142486	400	RECREATION AREA	1 /1	12/31
	MARYS RESTAURANT CATFISH AND MORE	MO1212807	25	RESTAURANT	1 /1	12/31
	NEW HOME BAPTIST CHURCH	MO1271508	25	OTHER NON-TRANSIENT AREA	1 /1	12/31
	OSAGE BLUFF STUFF	MO3242487	14	RECREATION AREA	4 /1	10/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
BENTON	PECAN GROVE CAMPGROUND	MO3241403	125	RECREATION AREA	4 /1	10/31
	PORT BERRY RV PARK	MO3242415	25	RECREATION AREA	1 /1	12/31
	PUMP N MUNCH	MO1292877	25	SERVICE STATION	1 /1	12/31
	REEDS RV PARK AND STORAGE	MO1282815	204	OTHER TRANSIENT AREA	3 /1	11/30
	REEL & TRIGGER RESORT	MO3190260	35	HOTEL/MOTEL	1 /1	12/31
	REGAL BELOIT AMERICA INC	MO3181385	140	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	RIVERS END MOTEL	MO3190266	40	HOTEL/MOTEL	1 /1	12/31
	ROCKY TOP RV PARK	MO3212287	25	RESTAURANT	1 /1	12/31
	RUTH MERCER ELEMENTARY SCHOOL	MO3170930	170	SCHOOL	1 /1	12/31
	SHADY OAKS RV PARK LLC	MO1282813	75	OTHER TRANSIENT AREA	4 /1	9 /30
	STERETT CREEK MARINA	MO3100031	41	OTHER TRANSIENT AREA	1 /1	12/31
	THE LAST RESORT CAMPGROUND	MO3242570	150	RECREATION AREA	1 /1	12/31
	THE OLD OAR HOUSE INN	MO3201440	30	RESTAURANT	3 /1	9 /30
	TRUMAN DAM RV PARK	MO3242598	165	RECREATION AREA	5 /1	10/31
	TRUMAN LAKE RESORT LLC	MO3242534	100	RESTAURANT	3 /1	10/31
	TURKEY CREEK RV PARK	MO1243149	25	OTHER TRANSIENT AREA	1 /1	12/31
	UNCLE GABBYS MOTEL	MO1192722	25	HOTEL/MOTEL	1 /1	12/31
	USACE TRUMAN BERRY BEND NORTH	MO3112282	50	RECREATION AREA	1 /1	12/31
	USACE TRUMAN LONG SHOAL PUA	MO3112192	100	RECREATION AREA	1 /1	12/31
	USACE TRUMAN OSAGE BLUFF PUA	MO3112193	100	RECREATION AREA	1 /1	12/31
	USACE TRUMAN SHAWNEE BEND	MO3112283	50	RECREATION AREA	1 /1	12/31
	USACE TRUMAN THIBAUT POINT	MO3112284	100	RECREATION AREA	1 /1	12/31
	USACE TRUMAN VISITOR CENTER	MO3112196	75	RECREATION AREA	1 /1	12/31
	WARSAW R IX HIGH SCHOOL	MO3171247	460	SCHOOL	1 /1	12/31
	WARSAW R IX SOUTH ELEM	MO3171120	150	SCHOOL	1 /1	12/31
	WARSAW SHRINE CLUB	MO1202872	25	OTHER TRANSIENT AREA	1 /1	12/31
BOLLINGER	CASTOR RIVER PARK	MO4243043	35	OTHER TRANSIENT AREA	1 /1	12/31
	DOLLAR GENERAL 16317 BOLLINGER	MO4283197	25	RETAIL EMPLOYEES	1 /1	12/31
	MEADOW HTS R II HIGH SCHOOL	MO4171248	580	SCHOOL	1 /1	12/31
	NEW SALEM BAPTIST CHURCH	MO4172719	150	OTHER TRANSIENT AREA	1 /1	12/31
	PATTON JUNCTION SERVICES INC	MO4292325	25	SERVICE STATION	1 /1	12/31
	TWIN BRIDGES PARK	MO4242884	60	SUMMER CAMP	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
BOLLINGER	WHIPPOORWILL LAKE FAMILY CAMPGROUND	MO4243202	75	OTHER TRANSIENT AREA	1 /1	12/31
	WOODLAND R IV SCHOOLS	MO4171122	1050	SCHOOL	1 /1	12/31
	ZALMA R V SCHOOL	MO4171249	375	SCHOOL	1 /1	12/31
BUTLER	CRABB & COMPANY	MO4218506	100	RESTAURANT	2 /1	10/31
	MILLERS MOTOR LODGE	MO4191461	53	HOTEL/MOTEL	1 /1	12/31
	STOP & GO	MO4292680	120	SERVICE STATION	1 /1	12/31
CALLAWAY	AMEREN MISSOURI CALLAWAY ENERGY CENTER	MO3182219	860	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	HANSON HILLS	MO3240054	40	RECREATION AREA	1 /1	12/31
	SOUTH CALLAWAY COUNTY R II SCHOOLS	MO3171252	1100	SCHOOL	1 /1	12/31
CAMDEN	11 WEST CONDOMINIUM	MO3238020	25	HOTEL/MOTEL	1 /1	12/31
	7 EXPRESS	MO5292984	100	OTHER TRANSIENT AREA	1 /1	12/31
	ALHONNA RESORT	MO3190682	150	HOTEL/MOTEL	1 /1	12/31
	AROUND THE BEND BARBQ	MO3212580	30	RESTAURANT	1 /1	12/31
	BASS COVE LODGE	MO3218227	30	HOTEL/MOTEL	5 /1	9 /30
	BAY POINT CONDOMINIUMS	MO3238099	150	OTHER TRANSIENT AREA	1 /1	12/31
	BAY POINT VILLAGE CONDO	MO3238034	400	RECREATION AREA	1 /1	12/31
	BAYMONT INN & SUITES	MO3190958	100	HOTEL/MOTEL	1 /1	12/31
	BAYWOOD CONDOMINIUM	MO3238271	40	OTHER TRANSIENT AREA	1 /1	12/31
	BELLA SERA CONDOS	MO5301556	25	RESIDENTIAL AREA	1 /1	12/31
	BELLA TERRA POA	MO5193213	30	RESIDENTIAL AREA	1 /1	12/31
	BENTWOOD CONDO	MO3238190	25	OTHER TRANSIENT AREA	1 /1	12/31
	BIG BEAR DUPLEXES	MO5303042	50	OTHER TRANSIENT AREA	1 /1	12/31
	BIG SURF WATERPARK INC	MO3208173	2500	RECREATION AREA	5 /28	9 /30
	BLUE CAT POINT	MO5252708	25	RESIDENTIAL AREA	1 /1	12/31
	BRIDAL CAVE DEVELOPMENT COMPANY INC	MO3212409	25	RESTAURANT	1 /1	12/31
	BULLDOGS BEACHHOUSE	MO3212581	75	RESTAURANT	3 /12	10/31
	CAMP HERITAGE	MO3248239	145	SUMMER CAMP	4 /1	9 /30
	CARDINAL COVE	MO3218029	25	RESTAURANT	3 /1	12/31
	CGS MINIMART	MO3292348	50	SERVICE STATION	1 /1	12/31
	CHIMNEY POINT ASSN	MO5252736	25	SUBDIVISION	1 /1	12/31
	CLIMAX SPRINGS R IV SCHOOLS	MO3171131	278	SCHOOL	1 /1	12/31
	COME ON IN CAFE	MO5212834	50	RESTAURANT	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
CAMDEN	COPPER RIDGE CONDO	MO3238111	60	OTHER TRANSIENT AREA	4 /1	10/31
	CREATIVE LEARNING DAY SCHOOL	MO5282999	35	OTHER TRANSIENT AREA	1 /1	12/31
	DEER CHASE GOLF	MO5202643	50	RECREATION AREA	1 /1	12/31
	DEER VALLEY PARK	MO3260059	200	RECREATION AREA	4 /1	10/31
	DOGWOOD ACRES RESORT	MO3192351	35	HOTEL/MOTEL	4 /1	10/31
	DOLLAR GENERAL #17357 CLIMAX SPRINGS	MO5283206	100	OTHER TRANSIENT AREA	1 /1	12/31
	DRIFTWOOD MHP	MO5193209	25	OTHER TRANSIENT AREA	1 /1	12/31
	EAGLE ROCK SUBDIVISION	MO3031307	37	SUBDIVISION	1 /1	12/31
	ECONO LODGE	MO3191702	50	HOTEL/MOTEL	1 /1	12/31
	EVERGREEN CONDOMINIUMS	MO3031336	50	SECONDARY RESIDENCES	1 /1	12/31
	FATTIES RENDEZVOUS	MO3218100	100	RESTAURANT	1 /1	12/31
	FISH & COMPANY	MO3212312	50	RESTAURANT	3 /1	10/31
	GARDEN GATE ESTATES	MO5301394	25	RESIDENTIAL AREA	1 /1	12/31
	GINGER COVE SUBDIVISION	MO3031323	25	SUBDIVISION	1 /1	12/31
	GLAIZE GLENMEADOWS SUBD	MO3031287	60	SECONDARY RESIDENCES	1 /1	12/31
	GOLDEN HORSESHOE RESORT	MO3190697	25	HOTEL/MOTEL	5 /1	9 /30
	GREENVIEW BAY SUBD	MO3031091	25	SUBDIVISION	1 /1	12/31
	GREENVIEW BETTERMENT ASSOCIATION	MO3180363	136	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	HA HA TONKA STATE PARK	MO3122153	250	RECREATION AREA	4 /1	10/31
	HALFWAY INN	MO3212416	100	RESTAURANT	3 /1	12/31
	HOHN SCOUT CAMP	MO3248224	151	SUMMER CAMP	4 /15	10/31
	HORIZONS AT THE LAKE CONDOS	MO3251432	45	OTHER RESIDENTIAL AREA	1 /1	12/31
	HURRICANE DOLLYS	MO3218012	25	RESTAURANT	1 /1	12/31
	HYD A WAY CONDOMINIUMS	MO5301443	75	OTHER TRANSIENT AREA	1 /1	12/31
	IRISH HILLS RESORT	MO3190763	25	HOTEL/MOTEL	4 /1	11/30
	JONATHANS LANDING	MO3238011	160	RECREATION AREA	1 /1	12/31
	JUST A LITTLE STORE	MO5293132	35	OTHER AREA	1 /1	12/31
	KAY LYNN RESORT	MO3191903	25	HOTEL/MOTEL	1 /1	12/31
	KE JO #IV HOA	MO5252903	25	SECONDARY RESIDENCES	1 /1	12/31
	KE JO POINT HOA	MO5252904	50	SECONDARY RESIDENCES	1 /1	12/31
	KELLYS PORT MARINA	MO5233202	25	OTHER TRANSIENT AREA	1 /1	11/30
	KEYSTONE VILLAGE CONDOS	MO3071239	25	OTHER RESIDENTIAL AREA	5 /1	9 /30

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
CAMDEN	KINGS POINTE	MO5193158	25	HOTEL/MOTEL	4 /1	10/31
	KOALA BEAR CONDOMINIUMS	MO3192145	50	HOTEL/MOTEL	1 /1	12/31
	LAKE ACRES HOMEOWNERS IMPROVEMENT ASSOCI	MO5031428	50	OTHER TRANSIENT AREA	1 /1	12/31
	LAKE BREEZE RESORT	MO3190784	35	HOTEL/MOTEL	1 /1	12/31
	LAKE BREEZE TERRACE	MO3212427	25	RESTAURANT	1 /1	12/31
	LAKE FOREST PROPERTY OWNERS	MO3190205	25	HOTEL/MOTEL	5 /1	10/31
	LAKE OZARK STATE PARK CLOVER POINT	MO5122664	125	RECREATION AREA	4 /15	10/31
	LAKE OZARK STATE PARK OUTPOST	MO5122670	25	RECREATION AREA	1 /1	12/31
	LAKE OZARK STATE PARK OZARK CAVERNS	MO5122669	50	OTHER TRANSIENT AREA	4 /15	10/31
	LAKE OZARK STATE PARK PIN OAK	MO5122666	100	RECREATION AREA	1 /1	12/31
	LAKE OZARK STATE PARK RED BUD	MO5122667	30	RECREATION AREA	4 /15	10/31
	LAKE OZARK STATE PARK RISING SUN	MO5122663	150	RECREATION AREA	4 /15	10/31
	LAKE REGIONAL HEALTH SYSTEM	MO3280530	600	OTHER TRANSIENT AREA	1 /1	12/31
	LAKE VALLEY CONDOMINIUM	MO3238026	150	HOTEL/MOTEL	1 /1	12/31
	LAKE VALLEY COUNTRY CLUB	MO3208008	75	RECREATION AREA	1 /1	12/31
	LAKEPOINTE CONDOMINIUMS	MO3238183	35	RESIDENTIAL AREA	5 /1	10/31
	LAKESHORE PLAZA	MO3281046	100	OTHER TRANSIENT AREA	1 /1	12/31
	LAKEVIEW BEACH RESORT	MO3191521	150	HOTEL/MOTEL	4 /1	11/30
	LARRYS ON THE LAKE	MO3212536	100	RESTAURANT	3 /1	11/30
	LAZY DAYS CONDOMINIUMS	MO3190706	573	HOTEL/MOTEL	1 /1	12/31
	LEDGE STONE ESTATES HOA	MO5252973	25	SECONDARY RESIDENCES	1 /1	12/31
	LITTLE NIANGUA CAMPGROUND	MO5242623	25	RECREATION AREA	1 /1	12/31
	LOCH HAVEN	MO5031413	100	RESIDENTIAL AREA	1 /1	12/31
	LONE OAK POINT CONDOMINIUMS	MO3190708	200	HOTEL/MOTEL	4 /1	10/31
	LONG ACRES SUBDIVISION	MO5251612	75	SUBDIVISION	1 /1	12/31
	MAPLE HILL SUBDIVISION	MO5253022	25	SECONDARY RESIDENCES	4 /1	10/31
	MICKEYLAND RESORT	MO3198088	35	HOTEL/MOTEL	1 /1	12/31
	MILLERS LANDING	MO3232609	25	RESTAURANT	4 /1	10/31
	MIMOSA BEACH CONDOMINIUMS	MO5301396	50	SUBDIVISION	4 /1	10/31
	MIMOSA BEACH POA	MO5252930	25	SECONDARY RESIDENCES	4 /16	10/31
	MIRAMAR CONDOMINIUMS	MO5301501	120	OTHER TRANSIENT AREA	1 /1	12/31
	MISSOURI TRAPSHOOTERS ASSOCIATION	MO5243013	25	OTHER TRANSIENT AREA	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
CAMDEN	MOCKINGBIRD BEACH SUBD	MO3031262	40	SUBDIVISION	4 /1	10/31
	MOONIES RESORT	MO3212429	25	RESTAURANT	4 /1	10/31
	NEIGHBORS LANDING	MO3212554	25	RESTAURANT	1 /1	12/31
	NEW LIFE CHURCH OF THE NAZARENE	MO5273016	134	OTHER TRANSIENT AREA	1 /1	12/31
	NIANGUA FALLS	MO3218236	25	RESTAURANT	5 /1	10/31
	NIANGUA VISTA CONDOMINIUMS	MO3302604	25	OTHER TRANSIENT AREA	4 /1	10/31
	OAK BLUFF CONDOMINIUMS	MO3302306	25	SECONDARY RESIDENCES	1 /1	12/31
	OAK POINT SUBDIVISION	MO3250972	25	SUBDIVISION	3 /1	11/30
	OH TOMMYS PUB & GRILL	MO5212774	60	RESTAURANT	1 /1	12/31
	OSAGE BEACH PREMIUM OUTLETS	MO3258182	3100	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	OSAGE HERITAGE CONDOMINIUMS	MO3238092	35	SECONDARY RESIDENCES	1 /1	12/31
	OSAGE VILLAGE INN	MO3191738	50	HOTEL/MOTEL	1 /1	12/31
	OZARK TRAILS FAMILY CAMPGROUND	MO3241442	100	OTHER TRANSIENT AREA	1 /1	12/31
	OZARK VILLAGE RESORT	MO3190749	75	HOTEL/MOTEL	3 /1	10/31
	PARADISE RESTAURANT	MO3218004	50	RESTAURANT	4 /1	9 /30
	PEACEFUL VALLEY RESORT	MO5243015	30	RECREATION AREA	4 /15	10/31
	PELICAN BAY CONDOMINIUMS	MO3238027	200	OTHER RESIDENTIAL AREA	1 /1	12/31
	POINT RANDALL RESORT	MO3192146	50	HOTEL/MOTEL	4 /1	10/31
	POINTE OASIS RESORT & MARINA	MO5212617	25	RESTAURANT	5 /1	9 /30
	POINTE ROYALE	MO5302865	75	SUBDIVISION	1 /1	12/31
	POINTE VIEW RESORT	MO3190710	50	HOTEL/MOTEL	4 /1	10/31
	PONDEROSA SUBDIVISION	MO3031261	25	SUBDIVISION	1 /1	12/31
	POPEYZ PIER 31	MO3212445	100	RESTAURANT	5 /1	9 /30
	PORT ROYALE CONDOS	MO3071313	75	OTHER RESIDENTIAL AREA	1 /1	12/31
	POSSUM HOLLER	MO3212540	25	RESTAURANT	3 /1	10/31
	POVERTY FLATS VILLAGE	MO3258106	25	RETAIL EMPLOYEES	1 /1	12/31
	QUAILS NEST INN & SUITES	MO3190760	150	HOTEL/MOTEL	1 /1	12/31
	QUICK STOP	MO3258265	50	OTHER TRANSIENT AREA	1 /1	12/31
	QUIET SIDE QUIK MART	MO5292791	100	SERVICE STATION	1 /1	12/31
	RAPID ROBERTS 117	MO3258093	100	SERVICE STATION	1 /1	12/31
	RASCALS TAVERN	MO5212764	25	RESTAURANT	1 /1	12/31
	RED FOX BAR & GRILL	MO3212446	100	RESTAURANT	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
CAMDEN	RED OAK RESORT	MO3240006	400	HOTEL/MOTEL	1 /1	12/31
	REFLECTIONS CONDOS	MO3071337	50	OTHER TRANSIENT AREA	1 /1	12/31
	RICHLAND DIVERSIFIED INDUSTRY	MO3180637	40	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	RIPPLING WATERS RESORT	MO3191748	70	HOTEL/MOTEL	4 /1	10/31
	RIVIERA VILLAS & RV RESORT	MO5301557	65	RECREATION AREA	1 /1	12/31
	ROANDA BEACH CONDOS	MO5303169	75	OTHER TRANSIENT AREA	1 /1	12/31
	ROCKWOOD RESORT MOTEL LLC	MO3190688	60	HOTEL/MOTEL	4 /1	10/31
	ROYALE PALMS	MO5301407	100	RESIDENTIAL AREA	4 /1	9 /30
	RUNAWAY II RESORT	MO3231654	25	SERVICE STATION	4 /1	10/31
	SEVEN SPRINGS WINERY	MO5212937	130	RESTAURANT	4 /1	10/31
	SHANGRI LA RESORT	MO3192066	65	HOTEL/MOTEL	4 /1	10/31
	SIERRA BAY CONDOMINIUMS	MO5301497	75	RESIDENTIAL AREA	1 /1	12/31
	SILVER SANDS MARINA & RESORT LLC	MO3190727	30	HOTEL/MOTEL	4 /1	10/31
	SIOUX TRAILS	MO3036216	72	SUBDIVISION	1 /1	12/31
	SKYLINE RESORT	MO3190728	35	HOTEL/MOTEL	4 /1	10/31
	SKYWATER ESTATES #1	MO5303170	25	OTHER TRANSIENT AREA	1 /1	12/31
	SORRENTO SQUARE OFFICE COMPLEX	MO5282711	25	OTHER NON-TRANSIENT AREA	1 /1	12/31
	SPEEDLINE TECHNOLOGIES INC	MO3182551	75	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	SPORTSMAN LODGE SUBDIVISION NO 2	MO5253086	25	OTHER TRANSIENT AREA	1 /1	12/31
	SPORTSMANS HARBOR CONDOMINIUMS	MO3190753	70	HOTEL/MOTEL	1 /1	12/31
	ST MORITZ ESTATES CONDO	MO3238024	75	HOTEL/MOTEL	1 /1	12/31
	ST MORITZ ON THE LAKE	MO3031297	25	SUBDIVISION	1 /1	12/31
	SUBWAY #56772	MO5213112	25	RESTAURANT	1 /1	12/31
	SUMMER HILL CONDOMINIUM ASSN INC	MO5301431	25	OTHER RESIDENTIAL AREA	1 /1	12/31
	SUN FOREST	MO5182985	30	OTHER TRANSIENT AREA	1 /1	12/31
	SUNRISE BAY CONDOMINIUMS	MO3280910	25	OTHER TRANSIENT AREA	4 /1	10/31
	SUNRISE POINT	MO3238193	25	RESIDENTIAL AREA	4 /1	10/31
	SUNRISE RIDGE CONDO	MO3238025	178	HOTEL/MOTEL	1 /1	12/31
	SUNSET BEACH RESORT	MO3190730	50	HOTEL/MOTEL	4 /1	10/31
	SUNSET INN RESORT	MO3190770	25	HOTEL/MOTEL	4 /1	10/31
	SUNSET PALMS CONDOMINIUMS	MO5301480	150	RESIDENTIAL AREA	1 /1	12/31
	SUNSET SHORES	MO5252902	25	SECONDARY RESIDENCES	1 /1	12/31

Noncommunity Water Systems

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CAMDEN	SWISS VILLAGE CONDO	MO3238050	34	RESTAURANT	1 /1	12/31
	TARA CONDOMINIUMS	MO3238222	30	HOTEL/MOTEL	4 /1	10/31
	THE BLUE HERON RESTAURANT	MO3218036	75	RESTAURANT	4 /1	11/30
	THE BREAKERS CONDOMINIUM	MO3238250	25	HOTEL/MOTEL	1 /1	12/31
	THE POINT SUBDIVISION	MO3031281	25	SUBDIVISION	1 /1	12/31
	THOMSONS COUNTRY STORE	MO5293009	100	OTHER TRANSIENT AREA	1 /1	12/31
	THREE SEASONS CONDO	MO3190750	50	HOTEL/MOTEL	1 /1	12/31
	TIMBERLAKE VILLAGE MHP	MO3040960	25	MOBILE HOME PARK	1 /1	12/31
	TIREBITERS	MO3211391	50	RESTAURANT	1 /1	12/31
	TRINITY POINTE CONDOMINIUMS	MO5301490	50	RESIDENTIAL AREA	1 /1	12/31
	TWIN COVES WATER ASSN	MO5031590	25	SECONDARY RESIDENCES	4 /1	10/31
	USACE LAKE OZARK RECREATION AREA	MO3202324	250	RECREATION AREA	1 /1	12/31
	VIKING POST 306	MO5212747	25	RESTAURANT	1 /1	12/31
	VISIONS CONDOMINIUMS	MO3031234	488	OTHER RESIDENTIAL AREA	1 /1	12/31
	WESTON POINT CONDOS	MO3238028	200	HOTEL/MOTEL	1 /1	12/31
	WILLOWES	MO5213012	25	RESTAURANT	1 /1	12/31
	WILSONS RESORT HOME ASSN	MO3191999	25	HOTEL/MOTEL	3 /1	10/31
	WINDERMERE BAPTIST CONFERENCE CENTER	MO3242220	1150	SUMMER CAMP	1 /1	12/31
	WINDGATE ON THE LAKE CONDOS	MO3301348	25	OTHER RESIDENTIAL AREA	1 /1	12/31
	WINDSOR BAY CONDOMINIUMS	MO3280837	25	OTHER TRANSIENT AREA	1 /1	12/31
	WINDWOOD CONDOMINIUM	MO3238038	25	RESIDENTIAL AREA	1 /1	12/31
	WINDWOOD SHORES	MO5252715	25	RESIDENTIAL AREA	4 /1	10/31
	WOOD CREST CONDOMINIUMS	MO3238098	100	RESIDENTIAL AREA	1 /1	12/31
	WOODBRIDGE SUBDIVISION	MO5253063	50	OTHER TRANSIENT AREA	1 /1	12/31
	WRENWOOD & ROBINWOOD CONDO	MO3191552	25	OTHER TRANSIENT AREA	1 /1	12/31
	Y ROAD GENERAL STORE	MO3258017	300	SERVICE STATION	1 /1	12/31
	Z 7 DISCOUNT FIREWORKS	MO3292426	25	RESTAURANT	4 /1	11/30
	ZACK WHEAT AMERICAN LEGION POST 624	MO3282519	50	OTHER TRANSIENT AREA	1 /1	12/31
CAPE GIRARDEAU	NELL HOLCOMB R 4 ELEMENTARY SCHOOL	MO4171142	375	SCHOOL	1 /1	12/31
	PROCTER & GAMBLE PAPER PROD CO	MO4180589	1250	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	RAPCO HORIZON COUNTY	MO4180578	100	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	RONS BUTCHER SHOP & GROCERY	MO4231318	25	SERVICE STATION	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
CAPE GIRARDEAU	TRAIL OF TEARS ST PARK VISITOR CENTER	MO4120180	50	RECREATION AREA	1 /1	12/31
	TRAIL OF TEARS STATE PARK CAMPGRD	MO4120170	500	RECREATION AREA	1 /1	12/31
	ZION UNITED METHODIST CHURCH	MO4270507	35	OTHER TRANSIENT AREA	1 /1	12/31
CARTER	OZARK NATL RIVER BIG SPRING	MO4102202	500	RECREATION AREA	1 /1	12/31
	ROYAL OAK ENTERP LLC ELLSINORE PLANT	MO4183206	85	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	SIMMONS GROCERY & HARDWARE	MO4292692	200	SERVICE STATION	1 /1	12/31
CEDAR	AIRPORT VILLAGE MHP	MO5238288	26	MOBILE HOME PARK	1 /1	12/31
	AMERICAN RESORTS HOA	MO5250889	48	RESIDENTIAL AREA	1 /1	12/31
	AMERICAN VETERANS POST 116	MO5282846	25	OTHER TRANSIENT AREA	1 /1	12/31
	BOAT HOUSE RESTAURANT & LOUNGE	MO5212832	25	RESTAURANT	1 /1	12/31
	CAPLINGER MILL CAMPGROUND	MO5242983	200	OTHER TRANSIENT AREA	5 /1	9 /30
	CEDAR SPRINGS AMISH MENNONITE SCHOOL	MO5171634	44	SCHOOL	8 /1	5 /31
	HAPPY OS SPORTSMAN RESORT	MO5193100	25	HOTEL/MOTEL	3 /1	10/31
	MT CARMEL INN	MO5191320	25	HOTEL/MOTEL	5 /1	10/31
	ORLEANS TRAIL RESORT	MO5190095	70	HOTEL/MOTEL	1 /1	12/31
	ORLEANS TRAIL RESTAURANT	MO5212752	100	RESTAURANT	4 /1	10/31
	STOCKTON STATE PARK CAMPGRD	MO5122154	163	RECREATION AREA	3 /15	10/31
	STOCKTON STATE PARK OFFICE	MO5122650	31	RECREATION AREA	3 /15	10/31
	USACE STOCKTON CEDAR RIDGE PARK	MO5110195	40	RECREATION AREA	4 /1	9 /30
	USACE STOCKTON CRABTREE COVE	MO5110200	40	RECREATION AREA	4 /1	9 /30
	USACE STOCKTON NORTH HAWKER POINT	MO5110190	35	RECREATION AREA	4 /1	9 /30
	USACE STOCKTON ORLEANS TRAIL PARK OT A	MO5110187	40	RECREATION AREA	5 /1	9 /30
	USACE STOCKTON ORLEANS TRAIL PARK OT B	MO5110188	38	RECREATION AREA	5 /1	9 /30
	USACE STOCKTON ORLEANS TRAIL PARK OT D	MO5110185	40	RECREATION AREA	5 /1	9 /30
	USACE STOCKTON PROJECT OFFICE	MO5110053	50	RECREATION AREA	4 /1	9 /30
	USACE STOCKTON SOUTH HAWKER POINT PARK	MO5110189	40	RECREATION AREA	5 /1	9 /30
	USACE STOCKTON STOCKTON AREA PARK	MO5110184	450	RECREATION AREA	4 /1	9 /30
	VIKINGS OFFICE BAR POST 129	MO5282827	25	OTHER TRANSIENT AREA	1 /1	12/31
CHRISTIAN	BRAMBLEWOOD GROUP HOME	MO5281373	25	INSTITUTION	1 /1	12/31
	BREAD OF LIFE SLAVIC CHURCH	MO5273217	350	OTHER TRANSIENT AREA	1 /1	12/31
	CAMP FINBROOKE	MO5228141	150	RECREATION AREA	3 /1	10/31
	COWBOY CORRAL	MO5291585	25	SERVICE STATION	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
CHRISTIAN	DELMINA WOODS	MO5150675	31	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	HOME AWAY FROM HOME LEARNING CENTER LLC	MO5172506	40	SCHOOL	1 /1	12/31
	LIFEPOINT CHURCH	MO5273003	385	OTHER TRANSIENT AREA	1 /1	12/31
	MILANO HOUSE	MO5071108	35	INSTITUTION	1 /1	12/31
	OZARK R VI SCHOOL DISTRICT - AG FACILITY	MO5173057	25	SCHOOL	1 /1	12/31
	OZARK UNITED METHODIST CHURCH	MO5272763	200	OTHER TRANSIENT AREA	1 /1	12/31
	SADDLEBROOKE VISITOR CENTER	MO5282624	25	OTHER TRANSIENT AREA	1 /1	12/31
	SELMORE BAPTIST CHURCH	MO5271645	200	OTHER TRANSIENT AREA	1 /1	12/31
	SPOKANE R VII SCHOOLS	MO5171596	435	SCHOOL	1 /1	12/31
	USFS COBB RIDGE REC AREA	MO5102421	25	RECREATION AREA	1 /1	12/31
COLE	17 EAGLE STOP	MO3292542	200	SERVICE STATION	1 /1	12/31
	COLE R V SCHOOL	MO3171146	700	SCHOOL	1 /1	12/31
	LOHMANS EAGLE STOP	MO3292565	500	SERVICE STATION	1 /1	12/31
	MISSOURI STATE CAPITOL	MO3152178	3100	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	STEVES FAMILY STYLE RESTAURANT	MO3212564	500	RESTAURANT	1 /1	12/31
	WREN ASSOCIATES	MO2182824	35	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
CRAWFORD	BASS RIVER RESORT	MO3241649	30	SUMMER CAMP	5 /1	9 /30
	BIRDS NEST LODGE	MO6190795	25	HOTEL/MOTEL	5 /1	9 /30
	BLUE SPRINGS RANCH	MO3241135	140	SUMMER CAMP	3 /1	10/31
	CAMP MIHASKA	MO3240249	250	SUMMER CAMP	1 /1	12/31
	COBBLESTONE LODGE	MO6190793	50	HOTEL/MOTEL	5 /1	9 /30
	CRAWFORD ELECTRIC COOP	MO3182434	64	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	CUBA LAKES GOLF AND COUNTRY CLUB	MO3202538	50	RECREATION AREA	1 /1	12/31
	DILLARD MILL HISTORIC SITE	MO6120153	25	RECREATION AREA	4 /1	10/31
	EAGLE HURST RANCH	MO6190794	45	HOTEL/MOTEL	6 /1	9 /30
	FOX SPRINGS LODGE	MO6190792	30	HOTEL/MOTEL	6 /19	9 /30
	GARRISONS CAMPGROUND AND CANOE RENTAL	MO3241036	300	RECREATION AREA	5 /1	9 /30
	HOLIDAY LAKE RV PARK	MO4202887	50	RECREATION AREA	5 /1	10/31
	HUZZAH VALLEY STABLES INC	MO3240880	150	RECREATION AREA	4 /1	10/31
	INDIAN SPRINGS	MO6192136	75	HOTEL/MOTEL	5 /1	8 /31
	KNIGHTS OF COLUMBUS HALL	MO3202428	25	RECREATION AREA	1 /1	12/31
	LEASBURG MOBIL	MO3290847	520	SERVICE STATION	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
CRAWFORD	LUCKY CLOVER RIVER RESORT INC	MO4242910	50	RECREATION AREA	5 /1	9 /30
	MERAMEC VALLEY CAMP RESORT	MO6210144	50	OTHER TRANSIENT AREA	1 /1	12/31
	ONONDAGA CAVE	MO6122199	50	RECREATION AREA	1 /1	12/31
	OZARK OUTDOOR RIVERFRONT RESORT	MO4192729	200	RECREATION AREA	4 /1	10/31
	RILEY SPENCE PROPERTIES NO 3	MO3212550	25	OTHER TRANSIENT AREA	1 /1	12/31
	SKIPPYS ROUTE 66 INN	MO3190845	25	HOTEL/MOTEL	1 /1	12/31
	STEELVILLE R III HIGH SCHOOL	MO6171255	300	SCHOOL	1 /1	12/31
	THE RAFTING COMPANY	MO4242627	25	SUMMER CAMP	4 /18	10/31
	USFS RED BLUFF CAMPGROUND	MO6100029	240	RECREATION AREA	5 /1	9 /30
	WHISPERING WINDS BIBLE CAMP	MO3241399	30	SUMMER CAMP	1 /1	12/31
DADE	EVENING STAR CAMPGROUND	MO5245232	30	RECREATION AREA	5 /1	9 /30
	MUTTON CREEK MARINA	MO5230535	111	OTHER TRANSIENT AREA	4 /1	10/31
	OAK RIDGE HILLS	MO5031363	29	SUBDIVISION	4 /1	10/31
	ONSTOTT/ORAHOOD SUBD	MO5251579	50	SUBDIVISION	1 /1	12/31
	SOUTHWINDS MOTEL	MO5212050	36	HOTEL/MOTEL	1 /1	12/31
	THREE HILLS SUBDIVISION	MO5031397	20	SUBDIVISION	1 /1	12/31
	USACE SOUTH MUTTON CREEK GROUP CAMP	MO5110199	200	RECREATION AREA	4 /1	10/1
	USACE STOCKTON MUTTON CREEK MARINA EAST	MO5110193	25	RECREATION AREA	4 /1	10/31
	USACE STOCKTON NORTH RUARK BLUFF	MO5110194	25	RECREATION AREA	4 /1	9 /30
	USACE STOCKTON RB GROUP CAMP RUARK BLUFF	MO5243018	25	OTHER TRANSIENT AREA	4 /1	9 /30
	USACE STOCKTON SE RUARK BLUFF AREA	MO5110198	600	RECREATION AREA	4 /1	9 /30
	USACE STOCKTON WEST RUARK BLUFF	MO5110197	100	RECREATION AREA	4 /1	9 /30
DALLAS	BENNETT SPRING STATE PARK WELL 3	MO5122658	151	RECREATION AREA	1 /1	12/31
	D DIAMOND TRAVEL PLAZA	MO5292380	25	SERVICE STATION	1 /1	12/31
	FORT NIANGUA RIVER RESORT	MO5210063	300	OTHER TRANSIENT AREA	3 /1	9 /30
	FRATERNAL ORDER OF THE BEARS 99	MO5282882	25	OTHER TRANSIENT AREA	1 /1	12/31
	HO HUMM CAMPGROUND	MO5240083	30	SUMMER CAMP	5 /25	9 /30
	HOSTETLER FEED & FARM SUPPLY	MO5283122	27	OTHER TRANSIENT AREA	1 /1	12/31
	LARRYS CEDAR RESORT	MO5191331	47	HOTEL/MOTEL	3 /1	10/31
	MENAGERIE CAMPGROUND	MO5242816	25	SUMMER CAMP	4 /1	10/31
	MR EDS DRIVE IN	MO5218053	50	RESTAURANT	1 /1	12/31
	NIANGUA RIVER OASIS	MO5248306	200	SUMMER CAMP	4 /1	9 /30

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
DALLAS	PRAIRIE GROVE SCHOOL	MO5172099	220	SCHOOL	1 /1	12/31
	SAND SPRING RESORT & CANOE LLC	MO5210911	175	RESTAURANT	3 /1	10/31
	WILD OAKS CAMPGROUND	MO5242820	50	RECREATION AREA	5 /1	10/31
DENT	DENT PHELPS ELEMENTARY SCHOOL	MO4171150	318	SCHOOL	1 /1	12/31
	GREEN FOREST ELEMENTARY SCHOOL	MO4171149	236	SCHOOL	1 /1	12/31
	MONTAUK STATE PARK	MO4120163	1200	RECREATION AREA	1 /1	12/31
	NEW HARMONY BAPTIST CHURCH	MO4172690	100	OTHER NON-TRANSIENT AREA	1 /1	12/31
	NORTHWOOD ELEMENTARY SCHOOL	MO4171151	250	SCHOOL	8 /1	5 /31
	OAK HILL ELEMENTARY SCHOOL	MO4171148	143	SCHOOL	8 /17	5 /31
	REEDS CABIN LLC	MO4190797	72	HOTEL/MOTEL	3 /1	10/31
	ROYAL OAK ENTERPRISES SALEM	MO4183208	50	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	SALEM WOOD PRODUCTS	MO4182302	60	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	VIRGINIA VAUGHAN RENTALS	MO4283064	28	OTHER TRANSIENT AREA	1 /1	12/31
	W G ARD # 1 LLC	MO4293034	35	OTHER TRANSIENT AREA	1 /1	12/31
DOUGLAS	AVA HEAD START	MO5172986	75	SCHOOL	8 /1	5 /31
	CACTUS CANYON CAMPGROUND	MO5072789	75	RECREATION AREA	4 /1	10/31
	FRATERNAL ORDER OF EAGLE 3748	MO5218158	30	RESTAURANT	1 /1	12/31
	JUNCTION STORE LLC	MO5211664	150	RESTAURANT	1 /1	12/31
	MT ZION BIBLE SCHOOL	MO5171804	75	SCHOOL	1 /1	12/31
	PLAINVIEW ELEM SCHOOL	MO5171805	128	SCHOOL	1 /1	12/31
	SKYLINE ELEMENTARY SCHOOL	MO5171803	119	SCHOOL	1 /1	12/31
	TWIN BRIDGES CANOE AND CAMPGROUND	MO5241141	38	RECREATION AREA	1 /1	12/31
FRANKLIN	CAMP MO VAL CAMP TAMBO	MO6241626	200	RESTAURANT	1 /1	12/31
	CAMP TRINITY	MO6242645	50	SUMMER CAMP	1 /1	12/31
	CAMP WOODLAND HILLS	MO6243055	25	OTHER TRANSIENT AREA	1 /1	12/31
	CAMPBELLTON ELEMENTARY SCHOOL	MO6171162	190	SCHOOL	1 /1	12/31
	CEDAR CREEK CONFERENCE CENTER	MO6192601	25	RESTAURANT	1 /1	12/31
	COLEMAN ELEMENTARY SCHOOL	MO6171155	485	SCHOOL	1 /1	12/31
	DOLLAR GENERAL LONEDELL #14038	MO6283182	25	OTHER TRANSIENT AREA	1 /1	12/31
	FRANKLIN COUNTY R II ELEMENTARY SCHOOL	MO6171154	218	SCHOOL	1 /1	12/31
	FRANKLIN COUNTY SPECIAL SCHOOL DIST	MO6171153	111	SCHOOL	1 /1	12/31
	K KWIK KORNER	MO6292966	30	SERVICE STATION	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
FRANKLIN	LONEDELL R XIV ELEMENTARY SCHOOL	MO6171159	475	SCHOOL	1 /1	12/31
	MERAMEC CAVERNS	MO6201448	400	RECREATION AREA	1 /1	12/31
	MERAMEC CAVERNS CAMPGROUND	MO6240239	25	RECREATION AREA	4 /1	10/31
	MERAMEC CAVERNS MOTEL	MO6190241	25	HOTEL/MOTEL	4 /1	10/31
	MERAMEC STATE PARK CAMPGRD	MO6122652	138	RECREATION AREA	1 /1	12/31
	MERAMEC STATE PARK DINING LODGE	MO6122651	100	RECREATION AREA	1 /1	12/31
	MERAMEC STATE PARK HICKORY RIDGE	MO6122653	68	RECREATION AREA	1 /1	12/31
	MERAMEC STATE PARK VISITOR CENTER	MO6120162	25	RECREATION AREA	1 /1	12/31
	NAT ASSOC INTERCULTURAL FAM MISSION INC	MO6283011	25	OTHER TRANSIENT AREA	1 /1	12/31
	NIKE ELEMENTARY SCHOOL	MO6171157	300	SCHOOL	1 /1	12/31
	PROSPECT BAPTIST CHURCH LONEDELL	MO6272942	50	OTHER TRANSIENT AREA	1 /1	12/31
	PURINA ANIMAL NUTRITION CENTER	MO6079502	150	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	ROBERTSVILLE ELEMENTARY SCHOOL	MO6171156	190	SCHOOL	1 /1	12/31
	ROBERTSVILLE STATE PARK	MO6120577	50	RECREATION AREA	1 /1	12/31
	SILVER OAKS	MO6203148	300	OTHER TRANSIENT AREA	1 /1	12/31
	SISTERS SALOON	MO6213200	25	RESTAURANT	1 /1	12/31
	SPRING BLUFF R XV ELEMENTARY SCHOOL	MO6171160	260	SCHOOL	1 /1	12/31
	STANTON MERAMEC KOA	MO6241577	100	RECREATION AREA	4 /1	11/30
	STRAIN JAPAN R 16	MO6171161	115	SCHOOL	1 /1	12/31
	ULTIMATE RIDES	MO6293156	25	OTHER TRANSIENT AREA	1 /1	12/31
	VFW POST 2482	MO6191843	30	OTHER TRANSIENT AREA	1 /1	12/31
	WAGNERS STORE	MO6292397	500	SERVICE STATION	1 /1	12/31
	WAYSIDE SOUTH	MO6292800	50	SERVICE STATION	1 /1	12/31
	WEDDING BELLS	MO6212311	50	RESTAURANT	1 /1	12/31
	WOLF HOLLOW GOLF CLUB	MO6202399	25	RECREATION AREA	4 /1	10/31
GASCONADE	BROWN SHANTY LAKE ASSN	MO6252212	25	SUBDIVISION	1 /1	12/31
	LOST VALLEY LAKE RESORT	MO3191470	150	HOTEL/MOTEL	1 /1	12/31
	OLD DUTCH MILL	MO6293060	50	OTHER TRANSIENT AREA	1 /1	12/31
	SCHAEPERKOETTER SALES	MO6203130	30	RECREATION AREA	1 /1	12/31
	SHEPHERD OF THE HILLS LUTHERAN CHURCH	MO3272482	25	OTHER TRANSIENT AREA	1 /1	12/31
	SILVER DOLLAR RESTAURANT	MO6211503	25	RESTAURANT	1 /1	12/31
GREENE	AGAPE LIFE FELLOWSHIP	MO5272441	50	OTHER TRANSIENT AREA	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
GREENE	ANDY DALTON SHOOTING RANGE TRN CTR	MO5141078	25	RECREATION AREA	1 /1	12/31
	BOLTONS GENERAL STORE	MO5258076	35	SUBDIVISION	1 /1	12/31
	BULLSEYE 37	MO5291060	250	OTHER TRANSIENT AREA	1 /1	12/31
	CENTER BAPTIST CHURCH	MO5273224	50	OTHER TRANSIENT AREA	1 /1	12/31
	COLONIAL MOTOR LODGE	MO5192051	31	HOTEL/MOTEL	1 /1	12/31
	CONCO QUARRIES	MO5188035	30	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	CROSSROADS EAGLE STOP	MO5258164	300	OTHER TRANSIENT AREA	1 /1	12/31
	DEERFIELD CENTRE	MO5292389	50	SERVICE STATION	1 /1	12/31
	DOLLAR GENERAL # 18619 ROGERSVILLE	MO5283236	25	OTHER TRANSIENT AREA	1 /1	12/31
	FARM CREDIT SERVICES FINANCIAL ACA	MO5183071	30	OTHER NON-TRANSIENT AREA	1 /1	12/31
	FELLOWSHIP BIBLE CHURCH	MO5272936	900	OTHER TRANSIENT AREA	1 /1	12/31
	GLIDEWELL BAPTIST CHURCH	MO5271861	25	OTHER TRANSIENT AREA	1 /1	12/31
	GREENE HILLS COUNTRY CLUB	MO5036094	100	RESTAURANT	4 /1	10/31
	HOODS SERVICE CENTER INC	MO5212053	1000	RESTAURANT	1 /1	12/31
	JD LEE & SONS FUNERAL HOME	MO5282754	25	OTHER TRANSIENT AREA	1 /1	12/31
	JM & M INVESTMENTS	MO5182849	50	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	JOHN TWITTY ENERGY CENTER	MO5188304	100	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	KAD E KORNER	MO5292515	25	SERVICE STATION	1 /1	12/31
	KRAFT HEINZ FOOD COMPANY	MO5180648	900	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	KUM & GO 498	MO5290086	1600	OTHER TRANSIENT AREA	1 /1	12/31
	LITTLE GUYS BASEBALL CLUB	MO5218149	150	RESTAURANT	1 /1	12/31
	LOGAN ROGERSVILLE ELEMENTARY SCHOOL	MO5171169	775	SCHOOL	1 /1	12/31
	LOGAN ROGERSVILLE ELEMENTARY SCHOOL	MO5171169	775	SCHOOL	1 /1	12/31
	LOGAN ROGERSVILLE HIGH SCHOOL	MO5172701	733	SCHOOL	1 /1	12/31
	LOGAN ROGERSVILLE MIDDLE SCHOOL	MO5171256	375	SCHOOL	1 /1	12/31
	NATHAN BOONE STATE HISTORICAL SITE	MO5122454	25	RECREATION AREA	4 /1	11/30
	PAUL MUELLER COMPANY	MO5181512	860	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	PHILLIPS 66 #258	MO5292347	300	SERVICE STATION	1 /1	12/31
	PLEASANT VIEW SCHOOLS	MO5172058	615	SCHOOL	1 /1	12/31
	RIDEWELL CORP	MO5182477	150	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	RITTER SPRINGS PARK	MO5161591	25	RECREATION AREA	4 /1	10/31
	SANCTUARY OF PRAISE CHURCH OF GOD/CHRIST	MO5271629	150	OTHER TRANSIENT AREA	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
GREENE	SOUTHWEST TREATMENT PLANT	MO5182118	50	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	SPRINGFIELD KOA	MO5240126	90	SUMMER CAMP	1 /1	12/31
	SPRINGFIELD LIVESTOCK MARKETING CTR	MO5282587	200	RESTAURANT	1 /1	12/31
	SPRINGFIELD SKATELAND	MO5210110	40	RESTAURANT	1 /1	12/31
	SPRINGHILL BAPTIST CHURCH	MO5272759	275	OTHER TRANSIENT AREA	1 /1	12/31
	SUNSHINE VALLEY FARM CAFE	MO5282404	30	RESTAURANT	1 /1	12/31
	TEMPLE ISRAEL	MO5271587	50	OTHER TRANSIENT AREA	1 /1	12/31
	THE SUMMIT CHURCH	MO5272956	125	OTHER TRANSIENT AREA	1 /1	12/31
	USDA FARM SERVICES BLDG	MO5102385	25	RECREATION AREA	1 /1	12/31
	VIRGILS BAR & SELF STORAGE	MO5212683	25	RESTAURANT	1 /1	12/31
	WILSON CREEK BAPTIST CHURCH	MO5272758	120	OTHER TRANSIENT AREA	1 /1	12/31
	WILSON CREEK BATTLEFIELD MONUMENT	MO5102181	100	RECREATION AREA	1 /1	12/31
	YRC INC	MO5181564	25	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
HENRY	HICKORY HOLLOW RESORT	MO1191290	220	HOTEL/MOTEL	4 /15	11/30
HICKORY	ALPS GROCERY PITTSBURG	MO5293126	25	RESTAURANT	1 /1	12/31
	BERRYLAND RV PARK & STORAGE	MO5243021	20	OTHER TRANSIENT AREA	1 /1	12/31
	BULLSEYE 34	MO5293002	25	OTHER TRANSIENT AREA	1 /1	12/31
	CAMP HEBRON	MO5243080	112	OTHER TRANSIENT AREA	3 /1	10/31
	CAPRI ESTATES	MO5252631	25	SUBDIVISION	1 /1	12/31
	COOPER COVE RESORT	MO5210919	45	HOTEL/MOTEL	1 /1	12/31
	GOODYS RESORT	MO5190914	75	HOTEL/MOTEL	4 /1	10/31
	HARBOR CAMPGROUND AND MARINA	MO5112098	165	RESTAURANT	4 /1	10/31
	HATHAWAY PETERMAN FUNERAL HOME	MO5282870	25	OTHER TRANSIENT AREA	1 /1	12/31
	HICKORY COUNTY R I SCHOOLS	MO5171257	700	SCHOOL	8 /1	6 /30
	HICKORY RIDGE HWY 83 MARINA & RESORT	MO5210920	75	RECREATION AREA	5 /1	11/30
	KEN HAVEN SUBD	MO5251510	63	SUBDIVISION	1 /1	12/31
	LINDLEY COVE WELL ASSOCIATION	MO5031456	34	SUBDIVISION	1 /1	12/31
	LOEHRS CAMPGROUND AND RESORT LLC	MO5242917	25	RECREATION AREA	4 /1	10/31
	MC CARTY SENIOR CENTER	MO5212329	90	RESTAURANT	1 /1	12/31
	NEMO BRIDGE RESORT	MO5192686	25	HOTEL/MOTEL	4 /1	10/31
	POMME DE TERRE STATE PARK	MO5120165	199	RECREATION AREA	4 /1	10/31
	POMME DE TERRES SHADOW LAKE GOLF COURSE	MO5218044	50	RECREATION AREA	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
HICKORY	POMME DE VILLA SUBDIVISION	MO5252968	12	SECONDARY RESIDENCES	1 /1	12/31
	PRAIRIE CHAPEL UMC	MO5283019	150	OTHER TRANSIENT AREA	1 /1	12/31
	REMINGTON RANGE	MO5251418	59	SUBDIVISION	1 /1	12/31
	STARLIGHT LANE SUBDIVISION	MO5252773	58	SECONDARY RESIDENCES	1 /1	12/31
	THUNDERBIRD COVE SUBD	MO5256205	30	SUBDIVISION	4 /1	9 /30
	TNT QUICK SHOP	MO5292918	380	SERVICE STATION	1 /1	12/31
	USACE POMME DE TERRE ADMIN	MO5110091	170	RECREATION AREA	4 /15	9 /30
	USACE POMME DE TERRE DAMSITE CAMP	MO5110056	150	RECREATION AREA	4 /1	9 /30
	USACE POMME DE TERRE LIGHTFOOT LANDING	MO5112090	180	RECREATION AREA	4 /1	9 /30
	USACE POMME DE TERRE NEMO AREA PARK	MO5110096	400	RECREATION AREA	4 /15	9 /30
	USACE POMME DE TERRE PITTSBURG PUA	MO5110099	40	RECREATION AREA	4 /1	9 /30
	USACE POMME DE TERRE WHEATLAND AREA	MO5112095	150	RECREATION AREA	4 /15	9 /30
	WHITESIDE HIDDEN ACRES CAMPGROUND # 2	MO5243041	25	OTHER TRANSIENT AREA	1 /1	12/31
	WHITESIDE HIDDEN ACRES CAMPGROUND #1	MO5243040	25	OTHER TRANSIENT AREA	1 /1	12/31
	WINDMILL POINT	MO5251481	88	SUBDIVISION	5 /1	9 /30
HOWELL	BULLSEYE 24	MO4292995	50	OTHER TRANSIENT AREA	1 /1	12/31
	DOLLAR GENERAL #14060 CAULFIELD	MO4283136	25	OTHER AREA	1 /1	12/31
	DOLLAR GENERAL #18296 SOUTH FORK	MO4283226	25	OTHER TRANSIENT AREA	1 /1	12/31
	HOWELL OREGON ELECTRIC COOP INC	MO4183083	60	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	LIGHTNING BOWL	MO4282521	100	OTHER TRANSIENT AREA	1 /1	12/31
	OZARK DEVELOPMENT CORP	MO4181616	250	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	ROADRUNNER RV PARK	MO4273178	60	OTHER TRANSIENT AREA	1 /1	12/31
	SOUTH FORK ELEMENTARY SCHOOL	MO4171176	250	SCHOOL	1 /1	12/31
IRON	21 EXPRESS	MO4292490	100	SERVICE STATION	1 /1	12/31
	BELLEVIEW ELEMENTARY SCHOOL	MO4171180	143	SCHOOL	1 /1	12/31
	BIG CREEK RV PARK	MO4242940	25	OTHER TRANSIENT AREA	1 /1	12/31
	BIXBY COUNTRY STORE	MO4258537	100	RESIDENTIAL AREA	1 /1	12/31
	CAMP PENUEL	MO4242733	110	SUMMER CAMP	6 /1	8 /31
	DOE RUN COMPANY BUICK SMELTER	MO4180635	300	OTHER NON-TRANSIENT AREA	1 /1	12/31
	DOE RUN COMPANY GLOVER PLANT	MO4181648	25	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	DOE RUN COMPANY VIBURNUM 35	MO4180665	65	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	DOE RUN COUNTRY CLUB	MO4202634	35	OTHER TRANSIENT AREA	1 /1	12/31

Noncommunity Water Systems

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IRON	DOE RUN COUNTY BUICK MINE MILL	MO4180634	200	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	TAUM SAUK STATE PARK	MO4121412	25	RECREATION AREA	4 /1	10/31
	USFS COUNCIL BLUFF BEACH	MO6102141	143	RECREATION AREA	5 /1	9 /30
	USFS COUNCIL BLUFF CAMPGROUND	MO6102180	50	RECREATION AREA	4 /15	10/31
JACKSON	LAKE CITY ARMY AMMUNITION PLT	MO1079505	3167	RECREATION AREA	1 /1	12/31
JASPER	66 DRIVE IN THEATRE	MO5283199	25	RECREATION AREA	4 /1	10/31
	AJINOMOTO WINDSOR	MO5180614	150	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	AVILLA ELEMENTARY SCHOOL	MO5171181	200	SCHOOL	1 /1	12/31
	BALLARDS CAMPGROUND	MO5241754	50	SUMMER CAMP	1 /1	12/31
	BEAGLE BAY RV HAVEN & CAMPGROUND	MO5241246	50	OTHER TRANSIENT AREA	3 /1	12/31
	BIG RED BARN RV PARK	MO5242916	25	OTHER TRANSIENT AREA	1 /1	12/31
	BYKOTA CHURCH	MO5272301	200	OTHER TRANSIENT AREA	1 /1	12/31
	COACHLIGHT RV PARK	MO5202945	18	RECREATION AREA	5 /1	11/30
	CROSSROADS BAPTIST CHURCH	MO5273127	150	OTHER AREA	1 /1	12/31
	DYNO NOBEL	MO5180607	270	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	FLYIN W CONVENIENCE STORE	MO5258080	25	SERVICE STATION	1 /1	12/31
	GENERAL DYNAMICS	MO5182965	120	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	JOPLIN REGIONAL STOCKYARDS	MO5212528	35	RESTAURANT	1 /1	12/31
	KUM & GO 29	MO5292802	25	OTHER TRANSIENT AREA	1 /1	12/31
	LEGACY BARN EVENT CENTER	MO5283198	25	OTHER TRANSIENT AREA	1 /1	12/31
	LEGGETT & PLATT	MO5180608	372	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	NEW COVENANT CHURCH	MO5172883	35	SCHOOL	1 /1	12/31
	PLEASANT VALLEY MHP	MO5041599	25	OTHER TRANSIENT AREA	1 /1	12/31
	PUMP N PANTRY OF DIAMOND	MO5292997	25	OTHER TRANSIENT AREA	1 /1	12/31
	QUAKERMILL PARK AND GROCERY	MO5258132	79	SERVICE STATION	1 /1	12/31
	RED OAK II CAFE	MO5210884	25	RESTAURANT	1 /1	12/31
	SUNSHINE CHILDRENS HOME	MO5170939	45	INSTITUTION	1 /1	12/31
JEFFERSON	AMEREN U E RUSH ISLAND	MO6182217	250	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	CAMP CEDARLEDGE	MO6240040	300	SUMMER CAMP	1 /1	12/31
	CEDAR HILL #508	MO6292410	50	SERVICE STATION	1 /1	12/31
	CEDAR SPRINGS ELEMENTARY SCHOOL	MO6171877	560	SCHOOL	1 /1	12/31
	DESOTO EAST HIGHWAY SHED	MO6162637	25	OTHER NON-TRANSIENT AREA	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
JEFFERSON	DITTMER BP#24	MO6293194	25	OTHER TRANSIENT AREA	1 /1	12/31
	DOLLAR GENERAL DESOTO #13971	MO6283184	50	OTHER TRANSIENT AREA	1 /1	12/31
	DON ROBINSON STATE PARK	MO6123219	25	OTHER TRANSIENT AREA	1 /1	12/31
	FRIENDSHIP BAPTIST CHURCH	MO6272944	100	OTHER TRANSIENT AREA	1 /1	12/31
	GRANDVIEW R 2 SCHOOL	MO6171788	350	SCHOOL	1 /1	12/31
	HILLSBORO WEST HIGHWAY SHED	MO6162638	25	OTHER NON-TRANSIENT AREA	1 /1	12/31
	HOUSE SPRINGS CHURCH OF CHRIST	MO6273211	55	OTHER TRANSIENT AREA	1 /1	12/31
	JAN PHILLIPS LEARNING CENTER	MO6173152	25	OTHER TRANSIENT AREA	1 /1	12/31
	JEFFERSON COUNTPARKS DEPT SPORTS COMPLEX	MO6203084	25	RECREATION AREA	1 /1	12/31
	LIVING WELL VILLAGE	MO6241571	25	SUMMER CAMP	1 /1	12/31
	MAPLE GROVE ELEMENTARY SCHOOL	MO6170130	515	SCHOOL	1 /1	12/31
	OUR LADY QUEEN OF PEACE	MO6172825	240	SCHOOL	1 /1	12/31
	PARSONS OIL COMPANY LLC	MO6292713	25	SERVICE STATION	1 /1	12/31
	PRO STOP	MO6292691	50	SERVICE STATION	1 /1	12/31
	RIVER CEMENT COMPANY	MO6180934	140	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	SERVGAS FAST MART	MO6293163	500	SERVICE STATION	1 /1	12/31
	ST MARTINS UCC CHURCH	MO6270498	25	OTHER TRANSIENT AREA	1 /1	12/31
	SUNNYHILL ADVENTURES	MO6171881	25	SUMMER CAMP	1 /1	12/31
	SUNRISE R IX ELEMENTARY SCHOOL	MO6171184	400	SCHOOL	1 /1	12/31
	TEAMSTER HEALTH & MEDICAL CAMP	MO6240133	275	RECREATION AREA	1 /1	12/31
	TEEN CHALLENGE OF ST LOUIS	MO6282572	35	OTHER TRANSIENT AREA	1 /1	12/31
	TIMBER CREEK RESORT	MO6191991	200	HOTEL/MOTEL	1 /1	12/31
	VILLA ANTONIO WINERY	MO6213191	800	RESTAURANT	1 /1	12/31
JOHNSON	A LITTLE OFF BASE	MO1041099	30	RESTAURANT	1 /1	12/31
	KNOB NOSTER STATE PARK SHAWNEE	MO1122656	160	RECREATION AREA	4 /1	10/31
LACLEDE	BENNETT SPRING STATE PARK WELL 1	MO5120148	322	RECREATION AREA	1 /1	12/31
	BENNETT SPRING STATE PARK WELL 2	MO5122657	322	RECREATION AREA	1 /1	12/31
	BENNETT SPRINGS CAMPGROUND 1	MO5240034	200	SUMMER CAMP	3 /1	10/31
	COUNTRY STOP	MO5292775	100	SERVICE STATION	1 /1	12/31
	FISHING TALES RV PARK & WEAVERS TACKLE	MO5240142	100	SUMMER CAMP	3 /1	10/31
	GASCONADE C 4 ELEMENTARY SCHOOL	MO5171189	60	SCHOOL	1 /1	12/31
	HIDDEN VALLEY OUTFITTERS	MO5243102	25	RECREATION AREA	4 /1	10/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
LACLEDE	J & J CAFE	MO5212762	70	SERVICE STATION	1 /1	12/31
	MOUNTAIN CREEK FAMILY RESORT	MO5240134	25	RECREATION AREA	4 /1	9 /30
	MUNGER MOSS MOTEL	MO5192285	75	HOTEL/MOTEL	1 /1	12/31
	SIGN FAB INC	MO5282611	71	OTHER NON-TRANSIENT AREA	1 /1	12/31
	STOUTLAND EAGLE STOP	MO5292470	25	SERVICE STATION	1 /1	12/31
LAWRENCE	3V CORP	MO5231809	59	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	AURORA WARD LDS CHURCH	MO5271720	150	OTHER TRANSIENT AREA	1 /1	12/31
	BAPTIST HILL ASSEMBLY	MO5242366	275	SUMMER CAMP	1 /1	12/31
	BAUMERS FOOD MART	MO5292361	350	SERVICE STATION	1 /1	12/31
	CAMP WAKONDA	MO5248289	50	SUMMER CAMP	5 /1	9 /30
	CHURCH IN ACTION	MO5273215	120	OTHER TRANSIENT AREA	1 /1	12/31
	COUNTRY JUNCTION STORE	MO5258127	62	SERVICE STATION	1 /1	12/31
	DONS CROSSROADS	MO5211348	25	SERVICE STATION	1 /1	12/31
	FRATERNAL ORDER OF EAGLE 3948	MO5218153	50	RESTAURANT	1 /1	12/31
	FREEDOM CHRISTIAN CENTER	MO5272726	25	OTHER TRANSIENT AREA	1 /1	12/31
	HONEYCREEK GOLF CLUB	MO5218165	100	RESTAURANT	4 /1	10/31
	HUNGRY HOUSE CAFE	MO5212682	25	RESTAURANT	1 /1	12/31
	ISONOVA TECHNOLOGIES LLC	MO5180545	36	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	MASSIES SUPER STOP	MO5292369	25	SERVICE STATION	1 /1	12/31
	MITCHELL BUILDING	MO5283188	25	OTHER TRANSIENT AREA	1 /1	12/31
	MOUNT VERNON MIGRANT HEAD START	MO5172932	39	DAY CARE CENTER	7 /1	9 /30
	ROUND GROVE BAPTIST CHURCH & SCHOOL	MO5270392	100	SCHOOL	1 /1	12/31
	STOP & SHOP	MO5292360	25	SERVICE STATION	1 /1	12/31
	SUMMIT BAPTIST CHURCH	MO5270393	75	OTHER TRANSIENT AREA	1 /1	12/31
	SUNSET DRIVE IN	MO5280547	500	OTHER TRANSIENT AREA	4 /1	8 /31
LINCOLN	CAMP TUCKAHO	MO6240045	25	SUMMER CAMP	1 /1	12/31
	CASTLES GROCERY AND CAFE	MO6291625	50	SERVICE STATION	1 /1	12/31
	CHRIST CENTERED CHURCH	MO6273193	100	OTHER TRANSIENT AREA	1 /1	12/31
	COASTAL CARRIERS	MO6283208	25	OTHER NON-TRANSIENT AREA	1 /1	12/31
	DOLLAR GENERAL #16225 TROY	MO6283180	25	RETAIL EMPLOYEES	1 /1	12/31
	JR DIAMONDS	MO6212332	25	RESTAURANT	1 /1	12/31
	NORTH TROY BUSINESS PARK	MO6182514	30	INDUSTRIAL/AGRICULTURAL	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
LINCOLN	OLNEY TAVERN	MO6210657	25	RESTAURANT	1 /1	12/31
	OPERATING ENGINEERS TRAINING SCHOOL	MO6172340	30	SCHOOL	1 /1	12/31
	REDEMPTION RANCH MINISTRIES	MO6202975	50	RECREATION AREA	6 /1	9 /30
	ST ALPHONSUS SCHOOL	MO6170733	84	SCHOOL	1 /1	12/31
	SUN VALLEY GOLF COURSE	MO6200812	40	RECREATION AREA	1 /1	12/31
	SUNRISE RV PARK LLC	MO6243174	25	OTHER AREA	1 /1	12/31
	USACE WINFIELD ACCESS AREA	MO6110926	25	RECREATION AREA	1 /1	12/31
MADISON	PINECREST CAMP	MO4240671	160	SUMMER CAMP	1 /1	12/31
	USFS SILVER MINES CAMP	MO4100013	100	RECREATION AREA	5 /1	9 /30
MARIES	CROSSROADS CONVENIENCE STORE	MO4292847	700	OTHER TRANSIENT AREA	1 /1	12/31
	KINGSFORD MFG CO	MO3180610	120	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	MORELANDS CATFISH PATCH & STEAK HOUSE	MO3211025	45	RESTAURANT	1 /1	12/31
	ROLLA NATIONAL AIRPORT	MO3221427	30	OTHER TRANSIENT AREA	1 /1	12/31
	THOMAS QUICK STOP	MO3292561	50	SERVICE STATION	1 /1	12/31
	TURKEY HILL RANCH BIBLE CAMP	MO3242408	200	SUMMER CAMP	5 /1	11/30
	VICHY WYE RESTAURANT	MO3210835	50	RESTAURANT	1 /1	12/31
MCDONALD	BUFFALO CREEK BAPTIST CHURCH	MO5272955	400	OTHER TRANSIENT AREA	1 /1	12/31
	EAGLES NEST CAMPGROUND	MO5240157	50	SUMMER CAMP	5 /1	9 /30
	ELK O VUE RIVER PARK MHP	MO5041094	28	OTHER TRANSIENT AREA	1 /1	12/31
	ELK RIVER FLOATS & CAMPGROUND	MO5241356	400	SUMMER CAMP	5 /20	9 /30
	LEGENDS RESTAURANT AND BAR	MO5211235	50	RESTAURANT	1 /1	12/31
	MARY DEANS RESTAURANT	MO5210192	25	RESTAURANT	1 /1	12/31
	NEW LIFE FELLOWSHIP CHURCH	MO5272723	25	OTHER TRANSIENT AREA	1 /1	12/31
	PATTERSON HEIGHTS BAPTIST CHURCH	MO5272914	25	OTHER TRANSIENT AREA	1 /1	12/31
	SHADY BEACH CAMPGROUND	MO5240236	28	SUMMER CAMP	5 /1	9 /30
	SIMMONS FOODS INC	MO5181763	700	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	T & R SOUTHWESTERN CAFE	MO5211225	25	RESTAURANT	1 /1	12/31
	TARSCO BOLTED TANK	MO5180605	30	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	THE FILLING STATION	MO5291271	25	SERVICE STATION	1 /1	12/31
	TIFF STORE	MO5291270	25	SERVICE STATION	1 /1	12/31
	TWO SONS CAMPGROUND	MO5243143	25	OTHER TRANSIENT AREA	5 /1	9 /30
	VICTORY ROAD CHURCH	MO5272964	60	DAY CARE CENTER	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
MILLER	BENTLEYS RESTAURANT	MO5213059	150	RESTAURANT	1 /1	12/31
	C SITE BAR & GRILL	MO5212698	50	RESTAURANT	1 /1	12/31
	CALVARY CHAPEL LAKE OF THE OZARKS	MO5273082	150	OTHER TRANSIENT AREA	1 /1	12/31
	CAMP BAGNELL	MO3241749	100	RECREATION AREA	5 /1	11/30
	CEDAR JUNCTION	MO5292911	50	OTHER TRANSIENT AREA	1 /1	12/31
	CHULA VISTA SUBDIVISION	MO5252674	50	SUBDIVISION	1 /1	12/31
	CROSSCREEK RV PARK	MO3260916	50	MOBILE HOME PARK	4 /15	10/31
	DOLLAR GENERAL # 18741 BRUMLEY	MO3283237	30	OTHER TRANSIENT AREA	1 /1	12/31
	EAGLE LANES AND BEAR CREEK VALLEY GC	MO3202344	200	RECREATION AREA	1 /1	12/31
	EL RANCHO TRAVEL CENTER	MO3191296	350	HOTEL/MOTEL	1 /1	12/31
	KAISER INDUSTRIAL PARK	MO3291674	100	SERVICE STATION	1 /1	12/31
	LAKE OZARK STATE PARK ADMINISTRATION	MO5122662	25	RECREATION AREA	1 /1	12/31
	LAKE OZARK STATE PARK HOMESTEAD	MO5122661	500	RECREATION AREA	4 /1	10/31
	LAZY RIVER RESORT	MO3241751	50	RECREATION AREA	4 /1	10/31
	MAJESTIC OAKS PARK	MO3248174	50	RECREATION AREA	4 /1	10/31
	MILLER COUNTY HEALTH CENTER	MO5162714	25	OTHER TRANSIENT AREA	1 /1	12/31
	MILLER COUNTY JAIL	MO3162350	250	RECREATION AREA	1 /1	12/31
	MILLER COUNTY R III SCHOOLS	MO3171263	271	SCHOOL	1 /1	12/31
	MILLION SHOREWOOD LANDING	MO3241441	50	SUMMER CAMP	4 /1	10/31
	NORTHSHORE RV PARK AND CAMPGROUND	MO3240814	25	RECREATION AREA	4 /1	10/31
	OLD TOWN OSAGE	MO5212967	30	RESTAURANT	1 /1	12/31
	OSAGE BEACH RV PARK	MO3241904	20	RECREATION AREA	1 /1	12/31
	OSAGE RIVER FARM INC	MO5283144	18	OTHER AREA	1 /1	12/31
	OUR LADY OF THE SNOW SCHOOL	MO3178192	100	SCHOOL	1 /1	12/31
	PORT ARROWHEAD	MO3190813	100	HOTEL/MOTEL	1 /1	12/31
	RICKS C STORE & MORE	MO3291408	500	SERVICE STATION	1 /1	12/31
	RIVERVIEW RV PARK	MO3248179	60	RECREATION AREA	3 /1	10/31
	SHAWNEE BLUFF VINEYARD	MO5213177	30	RESTAURANT	1 /1	12/31
	SPINNAKER POINT	MO3190833	75	HOTEL/MOTEL	1 /1	12/31
	SUMMERHAVEN CONDOMINIUM OWNERS ASSN	MO3250943	75	SECONDARY RESIDENCES	1 /1	12/31
	THE HUT	MO3210828	100	RESTAURANT	1 /1	12/31
	TLC ONE STOP	MO3211085	150	RESTAURANT	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
MILLER	TOOTERS SALOON & STEAKHOUSE	MO3212296	75	RESTAURANT	1 /1	12/31
	TUSCUMBIA EAGLE STOP	MO3292544	200	SERVICE STATION	1 /1	12/31
	VILLAGE MARINA	MO3231730	33	OTHER TRANSIENT AREA	1 /1	12/31
	W 15 MINI MART LLC	MO5213046	25	RESTAURANT	1 /1	12/31
MONITEAU	BEE LINE	MO3290673	25	SERVICE STATION	1 /1	12/31
	BURGERS OZARK COUNTRY CURED HAMS	MO3180619	200	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	CHURCH OF LATTER DAY SAINTS TIPTON BRANC	MO2273113	40	OTHER TRANSIENT AREA	1 /1	12/31
	HIGH POINT ELEMENTARY SCHOOL	MO3171198	91	SCHOOL	1 /1	12/31
	LATHAM R V SCHOOL	MO3171199	62	SCHOOL	1 /1	12/31
MONTGOMERY	DANVILLE SINCLAIR	MO3291410	25	SERVICE STATION	1 /1	12/31
	ENDLESS SUMMER WINERY	MO6213199	100	RESTAURANT	1 /1	12/31
	GRAHAM CAVE STATE PARK CAMPGROUND	MO6120155	200	RECREATION AREA	4 /1	10/31
	GRAHAM CAVE STATE PARK OFFICE	MO6122671	25	RECREATION AREA	1 /1	12/31
	J D STREETT 170	MO6292898	200	RESTAURANT	1 /1	12/31
	KAN DO KAMPGROUND & RV PARK	MO3241117	40	RECREATION AREA	4 /1	11/30
	LAZY DAY CAMPGROUND	MO6241534	25	RECREATION AREA	4 /1	10/31
	LOUTRE MARKET	MO6282894	30	OTHER TRANSIENT AREA	1 /1	12/31
	LOUTRE SHORE COUNTRY CLUB	MO3281053	50	OTHER TRANSIENT AREA	1 /1	12/31
	NEW FLORENCE WOOD PRODUCTS	MO6180572	40	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
MORGAN	AMERICAN VETERANS POST 108	MO3281196	30	OTHER TRANSIENT AREA	1 /1	12/31
	AQUA VITAE ESTATES	MO5192693	25	SECONDARY RESIDENCES	4 /1	9 /30
	BASS POINT RESORT	MO5193135	75	HOTEL/MOTEL	4 /1	10/31
	BEACHWOODS CAMPGROUND	MO5243147	25	OTHER TRANSIENT AREA	4 /1	10/31
	BEAUTY VIEW RESORT	MO3192316	25	HOTEL/MOTEL	5 /1	9 /30
	CABANA JONES LAKESIDE BAR	MO3212568	100	RESTAURANT	4 /1	10/31
	CAMP SABRA	MO3190044	400	HOTEL/MOTEL	6 /1	8 /31
	COCONUTS	MO5212949	400	RESTAURANT	5 /1	9 /30
	COOL VALLEY 2014	MO3250819	25	SUBDIVISION	5 /1	9 /30
	CREEKSIDE RV PARK	MO3248267	25	SUMMER CAMP	4 /1	9 /30
	CROSS POINTE CAMP AND RETREAT CENTER	MO3240282	950	SUBDIVISION	1 /1	12/31
	DOLLAR GENERAL #13332	MO5283140	200	OTHER AREA	1 /1	12/31
	DOLLAR GENERAL #18016 GRAVOIS MILLS	MO5283228	100	RETAIL EMPLOYEES	1 /1	12/31

Noncommunity Water Systems

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MORGAN	FRIEDRICHS RESORT SUBD	MO3210020	50	SUBDIVISION	1 /1	12/31
	FROGS	MO3212300	100	RESTAURANT	3 /17	10/31
	G 2 M SUPER MART	MO3258215	750	SERVICE STATION	1 /1	12/31
	GRAVOIS VILLAGE CONDOS	MO3191285	25	HOTEL/MOTEL	1 /1	12/31
	HAVA SPACE RV PARK	MO3241404	30	SUMMER CAMP	1 /1	12/31
	HILLBILLY YACHT CLUB	MO3212583	54	RESTAURANT	1 /1	12/31
	HOLIDAY VALLEY SUBDIVISION	MO5253105	30	SECONDARY RESIDENCES	1 /1	12/31
	IVY BEND RESORT	MO3190821	25	HOTEL/MOTEL	1 /1	12/31
	JOLLY ROGERS	MO5212921	200	RESTAURANT	5 /1	9 /30
	KREATIVE KIDDOS PRESCHOOL & DAYCARE	MO5283214	50	DAY CARE CENTER	1 /1	12/31
	LAKE HOUSE CAFE	MO3212560	100	RESTAURANT	4 /1	10/31
	LAKE VIEW ESTATES POA	MO3031161	90	SUBDIVISION	1 /1	12/31
	LAKE WOOD CENTER	MO3182336	200	OTHER TRANSIENT AREA	1 /1	12/31
	LAKESHORE CONDOS	MO5193232	100	OTHER TRANSIENT AREA	4 /1	10/31
	LEHMANS RESTAURANT	MO3212558	250	RESTAURANT	1 /1	12/31
	LONG VALLEY RESORT	MO3241802	125	SUMMER CAMP	4 /1	10/31
	LUCKY POINT	MO3252169	25	SUBDIVISION	4 /1	10/31
	MOFFETT SUBDIVISION	MO5252728	75	SUBDIVISION	1 /1	12/31
	MORGAN COUNTY R II SOUTH	MO3171200	50	SCHOOL	1 /1	12/31
	NORTH SHORE CONDOMINIUMS	MO3238276	100	HOTEL/MOTEL	1 /1	12/31
	NORTHSHORE RESTAURANT & LOUNGE	MO3208269	100	RECREATION AREA	1 /1	12/31
	OKLATERRE MOBILE HOME PARK	MO3031345	50	SUBDIVISION	1 /1	12/31
	OSAGE COMMUNITY ELKS LODGE 2705	MO3252600	150	OTHER TRANSIENT AREA	1 /1	12/31
	OXFORD PEACEFUL VALLEY RESORT	MO3262592	25	OTHER RESIDENTIAL AREA	4 /1	10/31
	RAVAES RV RESORT	MO5202702	25	RECREATION AREA	6 /1	9 /30
	ROCK HARBOR RESORT	MO3190842	50	HOTEL/MOTEL	4 /1	10/31
	ROLLING HILLS COUNTRY CLUB	MO3202562	40	RECREATION AREA	1 /1	12/31
	SAFE HAVEN MENNONITE CHURCH	MO5273106	75	OTHER TRANSIENT AREA	1 /1	12/31
	SHELDON POINT HOA	MO3031227	70	SUBDIVISION	1 /1	12/31
	SKYLINE SUBDIVISION	MO5031589	25	SECONDARY RESIDENCES	1 /1	12/31
	SMILEYS SUBDIVISION # 2	MO5253023	25	SECONDARY RESIDENCES	5 /1	9 /30
	SOUTH COVE HOA	MO5032892	25	SECONDARY RESIDENCES	1 /1	12/31

Noncommunity Water Systems

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MORGAN	STILLWATER SUBDIVISION	MO3031259	30	SUBDIVISION	1 /1	12/31
	TAP & GRILL LAKESIDE BREW HAUS	MO5213161	150	RESTAURANT	5 /1	12/31
	TATERHOGGZ LLC	MO3211033	100	RESTAURANT	1 /1	12/31
	THE 5 DINER	MO3211428	100	RESTAURANT	1 /1	12/31
	THE ANCHORAGE PUB & MHP	MO3190822	50	RESTAURANT	1 /1	12/31
	THE LAKE HOUSE INN	MO5192697	30	HOTEL/MOTEL	1 /1	12/31
	THE VILLAS OF HARBOUR HILLS	MO5031482	50	OTHER TRANSIENT AREA	1 /1	12/31
	TRAFFIC JAM	MO5212933	75	RESTAURANT	1 /1	12/31
	TS FISH TALES BAR & GRILL	MO3218211	200	RESTAURANT	4 /1	10/31
	VENTURE VALLEY	MO5252959	25	SECONDARY RESIDENCES	1 /1	12/31
	VILLAGE OF GENTLE SLOPES	MO3190841	50	SECONDARY RESIDENCES	1 /1	12/31
	VINNYS CAFE AND LOUNGE	MO5212905	25	RESTAURANT	1 /1	12/31
	WASHBURN POINT SUBDIVISION	MO5252990	50	SECONDARY RESIDENCES	1 /1	12/31
	WONDERLAND CAMP	MO3240046	200	SUMMER CAMP	4 /1	11/30
NEW MADRID	ST JUDE INDUSTRIAL PARK	MO4180658	1200	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
NEWTON	86 SUPER STOP LLC	MO5258147	100	SERVICE STATION	1 /1	12/31
	BELIEVERS FAITH FELLOWSHIP	MO5272989	50	OTHER TRANSIENT AREA	1 /1	12/31
	BLUE SKY RV PARK	MO5242919	25	OTHER TRANSIENT AREA	1 /1	12/31
	BUDGET INN	MO5190928	40	HOTEL/MOTEL	1 /1	12/31
	C MART	MO5292823	50	SERVICE STATION	1 /1	12/31
	DOLLAR GENERAL #16263	MO5283190	1000	RETAIL EMPLOYEES	1 /1	12/31
	EAST NEWTON SCHOOL DIST	MO5172531	450	SCHOOL	1 /1	12/31
	GEARHEAD GRILL	MO5212635	25	RESTAURANT	1 /1	12/31
	GET N SPLIT	MO5292861	25	SERVICE STATION	1 /1	12/31
	HWY 59 CAFE	MO5211719	25	RESTAURANT	1 /1	12/31
	JOPLIN SHOAL CREEK RV	MO5242867	25	RECREATION AREA	1 /1	12/31
	KOA CAMPGROUND	MO5241734	30	SUMMER CAMP	1 /1	12/31
	LOVES TRAVEL STOP 282	MO5292463	75	OTHER NON-TRANSIENT AREA	1 /1	12/31
	MINTAHAMA PROGRAM CENTER	MO5241139	150	SUMMER CAMP	5 /1	7 /31
	MONARK BAPTIST CHURCH	MO5273008	50	OTHER TRANSIENT AREA	1 /1	12/31
	OPAL FOODS LLC	MO5063085	75	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	OZARK CAMP & RETREAT CENTER	MO5242384	100	SUMMER CAMP	1 /1	12/31

Noncommunity Water Systems

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NEWTON	OZARK STAVE PRODUCTS	MO5182750	30	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	PETRO STOPPING CENTER	MO5191569	900	SERVICE STATION	1 /1	12/31
	RACINE CHRISTIAN CHURCH	MO5272957	500	OTHER TRANSIENT AREA	1 /1	12/31
	SAGMOUNT BAPTIST YOUTH CAMP	MO5273216	250	OTHER TRANSIENT AREA	4 /1	10/31
	SENECA R 7 EARLY CHILDHOOD CENTER	MO5173099	63	SCHOOL	1 /1	12/31
	SILVER MOON FULL GOSPEL CHURCH	MO5272988	90	OTHER TRANSIENT AREA	1 /1	12/31
	SKATELAND	MO5242492	25	OTHER TRANSIENT AREA	1 /1	12/31
	TRINITY LEARNING CENTER	MO5172890	93	SCHOOL	8 /17	5 /31
	WESTVIEW ELEMENTARY SCHOOL	MO5171201	167	SCHOOL	8 /17	5 /31
	WHITE EAGLE SHOAL CREEK PLAZA	MO5212716	25	RESTAURANT	1 /1	12/31
	ZANS CREEKSIDE CMPGRND	MO5242495	30	SUMMER CAMP	1 /1	12/31
OREGON	COUCH R 1 SCHOOL	MO4171266	292	SCHOOL	1 /1	12/31
	USFS GREER CROSSING	MO4100065	50	RECREATION AREA	5 /1	10/31
OSAGE	BUSY BEE LEARNING ACADEMY	MO2172980	100	DAY CARE CENTER	1 /1	12/31
	CREATIVE KIDS LEARNING CENTER	MO2172928	55	DAY CARE CENTER	1 /1	12/31
	DIAMOND PET FOODS	MO3181615	30	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	MARI OSA DELTA	MO3190087	30	HOTEL/MOTEL	3 /1	11/30
	OSAGE COUNTRY CLUB	MO2202792	60	OTHER TRANSIENT AREA	1 /1	12/31
OZARK	CLOUD 9 RANCH CLUB INC	MO5232259	485	OTHER NON-TRANSIENT AREA	1 /1	12/31
	DAWT MILL AND CAMPGROUND	MO5240536	150	SUMMER CAMP	3 /1	11/30
	DORA R III SCHOOLS	MO5171207	421	SCHOOL	1 /1	12/31
	EVANS QUICK STOP #3	MO5192392	50	OTHER TRANSIENT AREA	1 /1	12/31
	LOST WOODS GOLF COURSE	MO5202448	30	RECREATION AREA	5 /1	9 /30
	MILLERS ONE STOP	MO5292636	25	SERVICE STATION	1 /1	12/31
	OUTPOST/RANCH HOUSE	MO5212896	30	RESTAURANT	1 /1	12/31
	OZARK PLAZA MOTEL & RV PARK	MO5211828	50	HOTEL/MOTEL	1 /1	12/31
	PETTIT CANOE RENTAL	MO5242739	150	RECREATION AREA	5 /1	8 /31
	RAINBOW TROUT & GAME RANCH	MO5201082	331	RECREATION AREA	1 /1	12/31
	ROYS STORE	MO5292331	100	SERVICE STATION	1 /1	12/31
	THEODOSIA MARINA RESORT INC	MO5191387	300	HOTEL/MOTEL	3 /1	10/31
	THORNFIELD ELEMENTARY SCHOOL	MO5171205	85	SCHOOL	1 /1	12/31
	TURKEY CREEK RANCH	MO5192286	150	HOTEL/MOTEL	4 /14	11/30

Noncommunity Water Systems

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OZARK	TWIN FORKS RESORT	MO5190867	45	HOTEL/MOTEL	5 /1	9 /30
	USACE BULLSHOALS PONTIAC PARK 135	MO5111138	25	RECREATION AREA	3 /15	10/31
	USACE NORFORK TECUMSEH PARK 31	MO5111819	30	RECREATION AREA	5 /1	9 /30
	USACE NORFORK UDALL PARK 30	MO5111816	30	RECREATION AREA	5 /1	9 /30
	USACE PONTIAC BOAT DOCK INC	MO5111823	400	RECREATION AREA	3 /15	10/31
	USFS HAMMOND CAMP	MO5100023	70	RECREATION AREA	4 /1	11/30
	USFS NORTH FORK RECREATION AREA	MO5100022	70	RECREATION AREA	5 /1	10/31
PERRY	BILLS PLACE	MO4218555	40	RESTAURANT	1 /1	12/31
	BUCHHEIT INC	MO4181392	50	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	ENERGY PANEL STRUCTURES INC	MO4182632	60	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	RHODES 101 CONVENIENCE STORE	MO4211072	100	RESTAURANT	1 /1	12/31
PETTIS	AUNT MARTHAS PRESCHOOL & DAY CARE	MO3172256	65	SCHOOL	1 /1	12/31
	BOTHWELL LODGE STATE HISTORIC SITE	MO3120151	120	RECREATION AREA	4 /1	10/31
	BUDGET HOST SUPER 7 MOTEL	MO3190893	30	HOTEL/MOTEL	1 /1	12/31
	BUDGET INN	MO3190887	33	HOTEL/MOTEL	1 /1	12/31
	CAMP BRANCH BAPTIST CHURCH	MO1272873	60	OTHER TRANSIENT AREA	1 /1	12/31
	CLARAS NORTH 65 CAFE	MO3218262	25	RESTAURANT	1 /1	12/31
	COUNTRYSIDE RV PARK	MO3242533	20	SUMMER CAMP	3 /1	10/31
	DICKIE DOO BAR B QUE	MO3218195	130	RESTAURANT	1 /1	12/31
	GENERAL CABLE	MO3180628	200	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	MAPLEWOOD CHURCH AND SCHOOL	MO1272803	80	SCHOOL	1 /1	12/31
	TYSON POULTRY INC	MO3180838	2000	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	WEST CENTRAL CHRISTIAN SERVICE	MO1242721	200	RESTAURANT	6 /1	9 /30
PHELPS	COOKIN FROM SCRATCH	MO4212742	200	RESTAURANT	1 /1	12/31
	GREAT CIRCLE DAYCARE	MO4172842	68	DAY CARE CENTER	1 /1	12/31
	LITTLE PRAIRIE BIBLE CAMP	MO4242857	75	SUMMER CAMP	6 /1	8 /31
	MATTS STEAKHOUSE	MO4212840	300	RESTAURANT	1 /1	12/31
	MERAMEC SPRINGS COUNTRY STORE	MO3201020	75	RECREATION AREA	3 /1	10/31
	PHEASANT ACRES RV PARK LLC	MO4243048	25	OTHER TRANSIENT AREA	4 /15	10/31
	RANDYS ROADKILL BBQ & GRILL	MO4212993	120	RESTAURANT	1 /1	12/31
	THE COUNTRY CAFE	MO3210677	45	RESTAURANT	1 /1	12/31
	THE JAMES FOUNDATION	MO3190089	100	RECREATION AREA	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
PHELPS	USFS LANE SPRING RECREATION AREA	MO3100011	25	RECREATION AREA	4 /1	10/31
PLATTE	COVENANT COVE RV RESORT	MO1243138	10	OTHER AREA	1 /1	12/31
POLK	BOLIVAR MUNICIPAL AIRPORT	MO5222460	45	OTHER TRANSIENT AREA	1 /1	12/31
	BRIGHTON ASSEMBLY OF GOD	MO5283052	300	OTHER TRANSIENT AREA	1 /1	12/31
	CASES CORNER	MO5258125	27	OTHER TRANSIENT AREA	1 /1	12/31
	CROSS ROADS RV PARK	MO5242117	75	RESIDENTIAL AREA	1 /1	12/31
	HOME COURT ADVANTAGE	MO5069073	32	INSTITUTION	1 /1	12/31
	RED CEDAR MOTEL AND RV PARK	MO5193115	25	HOTEL/MOTEL	1 /1	12/31
PULASKI	BOILING SPRING CAMPGROUND LLC	MO4243010	25	SUMMER CAMP	5 /1	9 /30
	GAS HOPPER II	MO3292388	40	SERVICE STATION	1 /1	12/31
	GASCONADE CHRISTIAN SVC CAMP	MO3242354	80	SUMMER CAMP	6 /1	7 /31
	GASCONADE HILLS	MO3190064	30	HOTEL/MOTEL	5 /1	10/31
	OAK HILLS COUNTRY CLUB	MO3202484	25	RECREATION AREA	3 /1	11/30
	OASIS TRAVEL PLAZA LLC	MO4293179	500	OTHER TRANSIENT AREA	1 /1	12/31
	RUBYS LANDING	MO4193238	25	OTHER TRANSIENT AREA	1 /1	12/31
RANDOLPH	ASSOCIATED ELECTRIC THOMAS HILL 3	MO2182290	265	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
REYNOLDS	BLACK RIVER LODGE INC	MO4190874	185	RECREATION AREA	5 /20	9 /30
	CENTERVILLE QUICK STOP LLC	MO4293001	65	OTHER TRANSIENT AREA	1 /1	12/31
	DOE RUN COMPANY BRUSHY CREEK	MO4180666	160	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	DOE RUN COMPANY FLETCHER M M	MO4180580	160	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	DOE RUN COMPANY SWEETWATER UNIT	MO4182135	200	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	DOE RUN COMPANY WEST FORK UNIT	MO4182221	95	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	JOHNSON SHUTINS STATE PARK	MO4120158	74	RECREATION AREA	1 /1	12/31
	LENNYS	MO4218522	25	RESTAURANT	1 /1	12/31
	LOGAN VALLEY CHRISTIAN RETREAT	MO4243133	40	SUMMER CAMP	1 /1	12/31
	MISSOURI TIE LLC	MO4183207	50	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	SHERWOOD FOREST CAMP	MO4240177	250	RECREATION AREA	3 /1	11/30
	SUNSET POINT RESORT	MO4190876	40	HOTEL/MOTEL	6 /1	9 /30
	TWIN RIVERS LANDING OUTFITTERS LLC	MO4190139	50	OTHER TRANSIENT AREA	5 /1	9 /30
	USACE CLEARWATER BLUFF VIEW 05C	MO4112021	493	RECREATION AREA	5 /1	9 /30
	USACE CLEARWATER BLUFF VIEW 19C	MO4110276	493	RECREATION AREA	5 /1	9 /30
	USACE CLEARWATER HIGHWAY K PARK 17C	MO4112017	404	RECREATION AREA	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
REYNOLDS	USACE CLEARWATER HWY K WEST	MO4112578	75	RECREATION AREA	5 /1	9 /30
	USACE CLEARWATER OLD HIGHWAY K PARK 14	MO4112020	25	RECREATION AREA	5 /1	9 /30
	USACE CLEARWATER PIEDMONT PARK 01C	MO4112015	600	RECREATION AREA	1 /1	12/31
	USACE CLEARWATER RESIDENT OFFICE 15C	MO4112019	226	RECREATION AREA	1 /1	12/31
	USACE CLEARWATER WEBB CREEK PARK 06C	MO4112018	80	RECREATION AREA	5 /1	9 /30
	USACE CLEARWATER WEBB CREEK PARK 16C	MO4112029	80	RECREATION AREA	5 /1	9 /30
	USFS SUTTON BLUFF REC AREA	MO4100015	100	RECREATION AREA	5 /1	10/31
	VALLEY SPRINGS YOUTH RANCH	MO4240141	65	SUMMER CAMP	1 /1	12/31
	WILDERNESS LODGE LIMITED RIVERS EDGE	MO4190878	50	HOTEL/MOTEL	5 /1	10/31
RIPLEY	GATEWOOD ELEMENTARY SCHOOL	MO4171216	145	SCHOOL	1 /1	12/31
	SUNSHINE ACRES CHILDCARE CENTER LLC	MO4173146	50	DAY CARE CENTER	1 /1	12/31
	USFS DEER LEAP CAMPGROUND	MO4100025	25	RECREATION AREA	4 /1	9 /30
	USFS FLOAT CAMP CAMPGROUND	MO4102223	25	RECREATION AREA	4 /1	9 /30
SCOTT	EXPRESS FUEL	MO4292673	300	SERVICE STATION	1 /1	12/31
SHANNON	BUNKER HILL RANCH	MO4190279	400	HOTEL/MOTEL	5 /1	10/31
	DISCOVERY MINISTRIES	MO4240104	25	SUMMER CAMP	3 /1	10/31
	ECHO BLUFF STATE PARK BLUFF & PAVILION	MO4243201	25	OTHER TRANSIENT AREA	3 /1	12/31
	ECHO BLUFF STATE PARK CAMPGROUND	MO4243200	25	OTHER TRANSIENT AREA	1 /1	12/31
	ECHO BLUFF STATE PARK LODGE	MO4240176	25	OTHER TRANSIENT AREA	1 /1	12/31
	JASON PLACE CAMPGROUND	MO4248525	100	SUMMER CAMP	5 /20	10/31
	LIBERTY MIDDLE SCHOOL	MO4172978	350	SCHOOL	1 /1	12/31
	LIBERTY SENIOR HIGH SCHOOL	MO4171258	348	SCHOOL	1 /1	12/31
	OZARK NATL RIVER AKERS CAMP	MO4102207	422	RECREATION AREA	1 /1	12/31
	OZARK NATL RIVER ALLEY SPRING	MO4102205	780	RECREATION AREA	1 /1	12/31
	OZARK NATL RIVER CEDARGROVE	MO4102208	66	RECREATION AREA	4 /15	10/31
	OZARK NATL RIVER LOG YARD CAMP	MO4102204	25	RECREATION AREA	5 /1	10/31
	OZARK NATL RIVER PULLTITE CAMP	MO4102206	422	RECREATION AREA	4 /15	10/31
	OZARK NATL RIVER ROUND SPRING	MO4100210	25	RECREATION AREA	1 /1	12/31
	OZARK NATL RIVER TWO RIVERS	MO4102203	50	RECREATION AREA	4 /15	10/31
	TWIN PINES CONSERVATION EDUCATION FACILI	MO4142876	30	RECREATION AREA	1 /1	12/31
	USFS LOGGERS LAKE	MO4100014	25	RECREATION AREA	5 /1	9 /30
ST CHARLES	BALDUCCI VINEYARDS	MO6213173	25	RESTAURANT	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
ST CHARLES	BOONE VALLEY GOLF CLUB	MO6201486	50	RECREATION AREA	1 /1	12/31
	BROEMMELSIEK PARK	MO6202782	50	RECREATION AREA	4 /1	10/31
	CHANDLER HILL VINEYARD	MO6282901	25	RECREATION AREA	1 /1	12/31
	CHEROKEE LAKES CAMP	MO6240106	100	RESIDENTIAL AREA	1 /1	12/31
	DANIEL BOONE HOME	MO6152912	25	RECREATION AREA	1 /1	12/31
	DOG PRAIRIE TAVERN LLC	MO6212591	30	RESTAURANT	1 /1	12/31
	GASMART HYWAY 67 MOBIL	MO6293181	300	OTHER TRANSIENT AREA	1 /1	12/31
	INDIAN CAMP CREEK PARK	MO6202712	300	RECREATION AREA	4 /1	10/31
	MONTELLE WINERY	MO6283166	100	RESTAURANT	1 /1	12/31
	NATIONAL CART COMPANY	MO6182491	150	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	NOBOLEIS VINEYARDS	MO6213187	25	RESTAURANT	1 /1	12/31
	NORTH SHORE MARINA	MO6232941	50	OTHER TRANSIENT AREA	4 /1	10/31
	ORCHARD FARM SCHOOLS	MO6171218	1600	SCHOOL	1 /1	12/31
	RIVER EDGE GASMART	MO6293185	400	SERVICE STATION	1 /1	12/31
	RIVERS PROJECT OFFICE	MO6112781	30	RECREATION AREA	1 /1	12/31
	ST CHARLES COUNTY AIRPORT	MO6222456	25	OTHER TRANSIENT AREA	1 /1	12/31
	ST JOSEPH PARISH	MO6173056	25	SCHOOL	1 /1	12/31
	ST PAUL KNIGHTS OF COLUMBUS HALL	MO6281285	200	RECREATION AREA	1 /1	12/31
	ST PAULS ELEMENTARY SCHOOL	MO6171217	200	SCHOOL	8 /1	5 /31
	SUNEDISON SEMICONDUCTOR	MO6180570	800	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	THIES FARM	MO6213036	25	RESTAURANT	4 /1	12/31
	TOWNE PARK	MO6163066	100	OTHER TRANSIENT AREA	4 /1	10/31
	WEST ALTON BAR AND GRILL	MO6213186	80	SERVICE STATION	1 /1	12/31
	WILDSCHUETZ BROTHERS FARM	MO6213205	100	RESTAURANT	1 /1	12/31
	YACHT CLUB OF ST LOUIS	MO6232479	50	RESTAURANT	4 /1	10/31
ST CLAIR	COLLINS PILOT 385	MO5212119	735	SERVICE STATION	1 /1	12/31
	COUNTRYSIDE TRADING POST	MO5291358	100	SERVICE STATION	1 /1	12/31
	H ROE BARTLE SCOUT RESERVATION	MO5248121	1800	SUMMER CAMP	1 /1	12/31
	KREBS MOBILE HOME LIVING	MO5238065	21	MOBILE HOME PARK	1 /1	12/31
	OSCEOLA CHEESE COMPANY	MO5232120	500	SERVICE STATION	1 /1	12/31
	OSCEOLA PUBLIC SCHOOL	MO5171551	575	SCHOOL	1 /1	12/31
	ROSCOE C 1 ELEMENTARY SCHOOL	MO5171219	90	SCHOOL	8 /15	5 /31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
ST CLAIR	SCOTTS ICONIUM STORE	MO5258124	100	SUBDIVISION	1 /1	12/31
	SUGARFOOT BARBEQUE	MO5213079	128	RESTAURANT	1 /1	12/31
	UNITED PRODUCERS INC	MO5218049	100	RESTAURANT	1 /1	12/31
	USACE TRUMAN BERRY BEND SOUTH	MO5113233	50	OTHER TRANSIENT AREA	1 /1	12/31
	USACE TRUMAN TALLEY BEND PUA	MO5112126	100	RECREATION AREA	1 /1	12/31
	WILDFLOWER INN	MO5212121	32	HOTEL/MOTEL	1 /1	12/31
ST FRANCOIS	FARMINGTON AMVETS POST 113	MO4250576	50	SUBDIVISION	1 /1	12/31
	FARMINGTON MENNONITE CHURCH	MO4273210	28	SCHOOL	1 /1	12/31
	HARVEST CHRISTIAN CENTER	MO4172969	100	DAY CARE CENTER	1 /1	12/31
	KIDZ WORLD DAYCARE & PRESCHOOL	MO4170531	44	SCHOOL	1 /1	12/31
	LAKE HANNA ASSN	MO4242474	200	RECREATION AREA	1 /1	12/31
	MRS THRASHERS ADVANCED LEARNING CENTER	MO4173134	35	SCHOOL	1 /1	12/31
	NELSONS MUSIC CITY	MO4282503	25	OTHER TRANSIENT AREA	1 /1	12/31
	NEW BEGINNINGS CHURCH	MO4273068	135	OTHER TRANSIENT AREA	1 /1	12/31
	OZARK STEEL FABRICATORS INC	MO4180581	60	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	RED CEDAR LODGE	MO4211659	30	HOTEL/MOTEL	1 /1	12/31
	ROSENERS MOTEL	MO4211606	956	RESTAURANT	1 /1	12/31
	ROYS #7	MO4292751	150	SERVICE STATION	1 /1	12/31
	S F SCOUT RANCH	MO4240120	800	SUMMER CAMP	1 /1	12/31
	SHAMROCK REST & LOUNGE	MO4210857	25	RESTAURANT	1 /1	12/31
	SHERRYS	MO4292597	212	SERVICE STATION	1 /1	12/31
	ST FRANCOIS COUNTRY CLUB INC	MO4202962	250	RECREATION AREA	1 /1	12/31
	ST FRANCOIS STATE PARK	MO4120167	125	RECREATION AREA	1 /1	12/31
	ST JOE STATE PARK	MO4122074	25	RECREATION AREA	1 /1	12/31
	STEPPING STONES PRESCHOOL & DAYCARE	MO4170524	25	DAY CARE CENTER	1 /1	12/31
	STONE PARK RESORT	MO4203093	25	RECREATION AREA	1 /1	12/31
	TERRACE OF FRENCH VILLAGE	MO4283101	75	OTHER TRANSIENT AREA	1 /1	12/31
	VCA PROPERTIES LLC	MO4212391	50	RESTAURANT	1 /1	12/31
ST LOUIS	ABERDEEN GOLF CLUB	MO6202688	25	RECREATION AREA	4 /1	10/31
	BABLER STATE PARK	MO6120147	500	RECREATION AREA	1 /1	12/31
	CRESCENT FARMS GOLF CLUB	MO6200549	100	RECREATION AREA	4 /1	9 /30
	GREENSFELDER COUNTY PARK	MO6162373	100	RECREATION AREA	1 /1	12/31

Noncommunity Water Systems

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ST LOUIS	HIDDEN VALLEY GOLF COURSE	MO6200625	100	RECREATION AREA	10/1	4 /30
	HOLIDAY INN AT SIX FLAGS	MO6190564	65	HOTEL/MOTEL	1 /1	12/31
	JAY HENGES RANGE	MO6140960	50	RECREATION AREA	1 /1	12/31
	JELLYSTONE PARK CMPGRD	MO6241111	25	OTHER TRANSIENT AREA	5 /1	9 /30
	LONE ELK COUNTY PARK	MO6202395	25	RECREATION AREA	1 /1	12/31
	MARIANIST RETREAT CENTER	MO6281482	25	RECREATION AREA	1 /1	12/31
	PARADISE VALLEY GOLF & COUNTRY CLUB	MO6200551	50	RECREATION AREA	4 /1	10/31
	PEVELY FARM GOLF CLUB	MO6202335	200	RECREATION AREA	4 /1	10/31
	ROCKWOODS RESERVATION	MO6142190	550	RECREATION AREA	1 /1	12/31
	SIX FLAGS ST LOUIS	MO6181967	3200	RECREATION AREA	1 /1	12/31
	TYSON RESEARCH CENTER	MO6282400	26	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	WEST TYSON COUNTY PARK	MO6202439	30	RECREATION AREA	1 /1	12/31
	WESTERN OIL COMPANY	MO6182498	25	SERVICE STATION	1 /1	12/31
	WILDHORSE CREEK AMOCO	MO6291618	25	SERVICE STATION	1 /1	12/31
	WORLD BIRD SANCTUARY	MO6282352	25	OTHER TRANSIENT AREA	1 /1	12/31
	WYMAN	MO6069092	50	SUMMER CAMP	1 /1	12/31
STE GENEVIEVE	CAMP BUTTERFLY	MO4190281	25	SUMMER CAMP	5 /1	10/31
	CAVE VINEYARD	MO4283025	90	OTHER TRANSIENT AREA	1 /1	12/31
	CHAUMETTE VINEYARD & WINERY	MO4213220	100	RESTAURANT	1 /1	12/31
	CROWN VALLEY MICRO BREWERY	MO4283124	115	OTHER TRANSIENT AREA	1 /1	12/31
	CROWN VALLEY WINERY	MO4282793	100	OTHER TRANSIENT AREA	4 /1	12/31
	HAWN STATE PARK	MO4120067	200	RECREATION AREA	1 /1	12/31
	HOLCIM US INC LEE ISLAND PROJECT	MO4182616	250	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	PEACEFUL VALLEY BAPTIST CAMP	MO4258565	65	OTHER TRANSIENT AREA	6 /3	10/31
STODDARD	CROWLEY RIDGE MENNONITE CHURCH & SCHOOL	MO4272826	35	SCHOOL	1 /1	12/31
	HWY 60 RV PARK/MORGAN RENTALS LLC	MO4203026	25	OTHER TRANSIENT AREA	1 /1	12/31
	MINGO NATIONAL WILDLIFE REFUGE	MO4102254	35	RECREATION AREA	1 /1	12/31
	NESTLE PURINA PETCARE COMPANY	MO4180594	240	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
STONE	ALPINE LODGE RESORT	MO5190970	50	HOTEL/MOTEL	4 /1	10/31
	ANGLERS BEND SUB REES 1ST ADDITION	MO5252629	90	OTHER TRANSIENT AREA	4 /1	10/31
	ANGLERS BEND UNIT 2	MO5250537	22	SUBDIVISION	1 /1	12/31
	ANTLERS RESORT	MO5190933	28	HOTEL/MOTEL	1 /1	12/31

Noncommunity Water Systems

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STONE	AREA 71 LLC	MO5261253	75	MOBILE HOME PARK	1 /1	12/31
	ARROWHEAD NAVAJO WELLOWNERS ASSOCIATION	MO5190987	25	HOTEL/MOTEL	1 /1	12/31
	AUNTS CREEK DEV 1ST ADD	MO5041140	40	MOBILE HOME PARK	1 /1	12/31
	AUNTS CREEK RV PARK & STORE	MO5258123	25	SUMMER CAMP	4 /1	10/31
	BAR M RESORT & CAMPGROUND	MO5191678	54	HOTEL/MOTEL	3 /1	10/31
	BAVARIAN VILLAGE RESORT	MO5190935	50	HOTEL/MOTEL	4 /1	12/31
	BILLYGAILS	MO5258135	25	RESTAURANT	1 /1	12/31
	BLACK OAK WATER & SEWER CO	MO5036267	352	SUBDIVISION	1 /1	12/31
	BLUE MOUNTAIN CAMPGROUND	MO5240219	28	SUMMER CAMP	4 /1	10/31
	BRADFORD INN	MO5191311	85	HOTEL/MOTEL	1 /1	12/31
	BRANSON TREEHOUSE ADVENTURES	MO5240732	210	SUMMER CAMP	1 /1	12/31
	BRIDGEPORT RESORT	MO5190983	72	HOTEL/MOTEL	1 /1	12/31
	BUTTERMILK SPRINGS WATER ASSN	MO5031125	25	SUBDIVISION	1 /1	12/31
	CALM WATERS RESORT	MO5191312	25	HOTEL/MOTEL	3 /1	11/30
	CAMP BARNABAS ON TABLE ROCK LAKE	MO5242436	25	SUMMER CAMP	6 /1	8 /31
	CAMPBELL POINT MARINA	MO5243072	200	OTHER TRANSIENT AREA	4 /1	11/30
	CAPE FAIR MARINA	MO5212976	25	OTHER TRANSIENT AREA	3 /1	10/31
	CARDINAL HILL COTTAGES	MO5192432	25	HOTEL/MOTEL	1 /1	12/31
	CARR LANE COUNTRY STOP	MO5258134	30	OTHER TRANSIENT AREA	1 /1	12/31
	CASTLEVIEW COUNTRY CLUB	MO5241680	323	RECREATION AREA	5 /1	9 /30
	CHALETS ON TABLE ROCK LAKE	MO5031553	25	RESIDENTIAL AREA	1 /1	12/31
	COMPTON RIDGE CAMP	MO5240050	250	HOTEL/MOTEL	4 /1	11/30
	COOL WATER COVE WATER WELL ASSN	MO5031127	35	SUBDIVISION	1 /1	12/31
	COTTAGE RESORT	MO5190965	47	HOTEL/MOTEL	4 /1	12/31
	CREST LODGE RESORT	MO5199993	60	HOTEL/MOTEL	4 /1	10/31
	CROOKED TREE SUBDIVISION	MO5031119	25	SUBDIVISION	4 /1	10/31
	CROSS ROADS STORE	MO5292589	25	SERVICE STATION	1 /1	12/31
	DEER RUN MOTEL	MO5240075	300	SUMMER CAMP	4 /2	12/31
	DEER RUN STORE	MO5190611	25	RESTAURANT	4 /1	11/30
	DOGWOOD CANYON	MO5211553	300	RESTAURANT	4 /1	11/30
	DOGWOOD VALLEY ESTATES	MO5238311	26	RESIDENTIAL AREA	1 /1	12/31
	DOLLAR GENERAL STORE #17672	MO5283223	25	OTHER TRANSIENT AREA	1 /1	12/31

Noncommunity Water Systems

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STONE	DOOLEY LODGES & RESORT	MO5190940	25	HOTEL/MOTEL	5 /1	10/31
	DOUBLE OAK RESORT	MO5190988	25	HOTEL/MOTEL	4 /1	10/31
	EDGEWATER VILLA RESORT	MO5191920	40	HOTEL/MOTEL	4 /1	10/31
	FIN AND FEATHER RESORT PROPERTY HOA	MO5190943	30	HOTEL/MOTEL	5 /27	9 /30
	FIRST BAPTIST CHURCH KIMBERLING CITY	MO5272909	25	OTHER TRANSIENT AREA	1 /1	12/31
	FISH HOOK RESORT	MO5190944	68	HOTEL/MOTEL	4 /1	10/31
	FISH N FUN RESORT	MO5190942	36	HOTEL/MOTEL	4 /1	10/31
	FLAT CREEK RESORT	MO5191681	45	HOTEL/MOTEL	1 /1	12/31
	FOUR SEASONS RESORTS	MO5190976	63	HOTEL/MOTEL	3 /1	10/31
	FUN IN THE SON MINISTRIES INC	MO5243120	25	OTHER TRANSIENT AREA	1 /1	12/31
	GALENA ABESVILLE ELEMENTARY SCHOOL	MO5171580	335	SCHOOL	1 /1	12/31
	GOLDEN ARROW RESORT	MO5191965	63	HOTEL/MOTEL	3 /1	12/31
	GRAND CRU LANDING AT THE LAKE SUB	MO5031492	25	SUBDIVISION	1 /1	12/31
	GRANDVIEW ACRES SUBD	MO5251628	27	SECONDARY RESIDENCES	1 /1	12/31
	GREEN VALLEY RESORT	MO5190993	51	HOTEL/MOTEL	5 /1	9 /30
	HAPPY VALLEY LODGE	MO5190945	25	HOTEL/MOTEL	4 /1	10/31
	HARTER HOUSE	MO5282522	35	OTHER NON-TRANSIENT AREA	1 /1	12/31
	HER LOY ESTATES SUBDIVISION	MO5253017	25	SECONDARY RESIDENCES	1 /1	12/31
	HIDE AWAY RESORT	MO5190971	45	HOTEL/MOTEL	4 /1	10/31
	HOLIDAY HIDEAWAY RESORT	MO5190986	35	HOTEL/MOTEL	4 /1	10/31
	HOLIDAY HILLS OF STONE COUNTY	MO5036188	30	SUBDIVISION	1 /1	12/31
	HUNTERS FRIEND RESORT INC	MO5190974	30	HOTEL/MOTEL	4 /1	10/31
	HURLEY BAPTIST CHURCH	MO5272963	100	OTHER TRANSIENT AREA	1 /1	12/31
	HURLEY CHURCH OF GOD	MO5273030	25	OTHER TRANSIENT AREA	1 /1	12/31
	INDIAN HILLS RESORT	MO5191931	30	HOTEL/MOTEL	4 /1	9 /30
	INDIAN POINT CONDOMINIUM	MO5250539	60	SUBDIVISION	1 /1	12/31
	INDIAN TRAILS RESORT	MO5190968	57	HOTEL/MOTEL	1 /1	12/31
	JACKSON HOLLOW ADDITION	MO5256172	50	SUBDIVISION	1 /1	12/31
	JJ JUNCTION	MO5292451	200	SERVICE STATION	1 /1	12/31
	JOE BALD MARKET	MO5293125	25	OTHER AREA	1 /1	12/31
	KANAKUK KAMP NO 2	MO5248295	2000	SUMMER CAMP	6 /1	8 /31
	KANAKUK KAMP NO 7	MO5240662	260	SUMMER CAMP	6 /1	8 /31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
STONE	KIMBERLING AREA SENIOR CENTER	MO5282512	25	OTHER TRANSIENT AREA	1 /1	12/31
	KIMBERLING INN AT TABLE ROCK RESORT	MO5211572	550	RESTAURANT	1 /1	12/31
	KINGS COVE RESORT	MO5191925	40	HOTEL/MOTEL	4 /1	10/31
	LAKEVIEW CAMPGROUND LLC	MO5240839	141	SUMMER CAMP	4 /1	10/31
	LAKEWAY 1 STOP	MO5292749	25	SERVICE STATION	1 /1	12/31
	LAZY LEES RESORT	MO5190949	100	HOTEL/MOTEL	1 /1	12/31
	LEISURE SHORES UNIT 1	MO5256026	80	HOTEL/MOTEL	1 /1	12/31
	LIGHTHOUSE LODGE RESORT	MO5191573	42	HOTEL/MOTEL	3 /1	11/30
	LIVES UNDER CONSTRUCTION BOYS RANCH	MO5061373	25	INSTITUTION	1 /1	12/31
	LONG BEND SUBD	MO5031233	50	SUBDIVISION	1 /1	12/31
	LUCKY 13 CONDO OWNERS ASSN	MO5190992	32	HOTEL/MOTEL	4 /1	10/31
	LUNKER LANDING RESORT	MO5190989	25	HOTEL/MOTEL	3 /1	10/31
	MAPLE HILL HOA	MO5253089	22	OTHER TRANSIENT AREA	3 /1	10/31
	MAPLE HILL RESTAURANT	MO5211927	30	RESTAURANT	1 /1	12/31
	MARINA INN	MO5191971	25	HOTEL/MOTEL	4 /15	11/30
	MILL CREEK RESORT	MO5190952	25	HOTEL/MOTEL	4 /1	10/31
	MOUNTAIN COUNTRY MOTOR INN	MO5198039	70	HOTEL/MOTEL	1 /1	12/31
	OAK HILL RESORT	MO5190985	30	HOTEL/MOTEL	4 /1	10/31
	OLD SOUTHERN INN	MO5190599	25	HOTEL/MOTEL	4 /1	12/31
	OZARK MOUNTAIN RESORT	MO5198285	791	HOTEL/MOTEL	1 /1	12/31
	PANORAMA POINT SUBDIVISION	MO5252743	25	RESTAURANT	1 /1	12/31
	PAPOULIS	MO5218160	70	RESTAURANT	2 /10	12/31
	PARMESANS PIZZERIA	MO5258136	25	SERVICE STATION	1 /1	12/31
	PINES COMMUNITY CHRISTIAN CHURCH	MO5273118	25	OTHER TRANSIENT AREA	1 /1	12/31
	PORT OF KIMBERLING MARINA & CMPGRD 119	MO5112272	25	RECREATION AREA	1 /1	12/31
	PORT OF KIMBERLNG MARINA & CMPGRND 117	MO5111968	800	RECREATION AREA	1 /1	12/31
	PORT OF KIMBERLNG MARINA & CMPGRND 118	MO5112271	25	RECREATION AREA	1 /1	12/31
	QUIET COVE SUBD	MO5036007	40	SECONDARY RESIDENCES	1 /1	12/31
	RANTZ COUNTRY EXPRESS	MO5292573	25	SERVICE STATION	1 /1	12/31
	ROCK LANE RESORT	MO5190955	150	HOTEL/MOTEL	1 /1	12/31
	ROCKWOOD RESORT	MO5301503	81	RESIDENTIAL AREA	1 /1	12/31
	SCHOONER CREEK RESORT	MO5190956	80	HOTEL/MOTEL	3 /1	11/30

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
STONE	SECURITY ACRES	MO5031120	22	SUBDIVISION	5 /1	9 /30
	SHADRACK RESORT	MO5190957	40	HOTEL/MOTEL	3 /1	9 /30
	SHADY ACRE MOTEL	MO5192929	40	HOTEL/MOTEL	1 /1	12/31
	SHEPHERD HILLS LUTHERAN CHURCH	MO5270521	105	OTHER TRANSIENT AREA	1 /1	12/31
	SHORE ACRES RESORT	MO5199988	51	HOTEL/MOTEL	4 /1	9 /30
	SHOW ME SHORES	MO5262776	80	MOBILE HOME PARK	1 /1	12/31
	SILVER BELL SUBDIVISION HOA INC	MO5252603	50	SUBDIVISION	1 /1	12/31
	SILVER DOLLAR CITY MARVEL CAVE	MO5201957	8501	RECREATION AREA	1 /1	12/31
	STARLIGHT VILLAGE	MO5030473	65	OTHER TRANSIENT AREA	1 /1	12/31
	STILLWATERS RESORT INC	MO5190969	50	HOTEL/MOTEL	1 /1	12/31
	STONEWATER COVE RESORT	MO5192523	25	HOTEL/MOTEL	1 /1	12/31
	STONY BROOK INN	MO5191952	30	HOTEL/MOTEL	4 /1	11/30
	TABLE ROCK LAKE CAMPGROUND	MO5240131	25	SUMMER CAMP	3 /1	10/31
	TABLE ROCK SHORES CAMPGROUND	MO5243075	25	OTHER TRANSIENT AREA	1 /1	12/31
	TABLE ROCK SPORTSMENS CLUB	MO5238059	100	SUBDIVISION	1 /1	12/31
	TALKING ROCKS ROAD BAPTIST CHURCH	MO5272979	93	OTHER TRANSIENT AREA	1 /1	12/31
	TALL PINES CAMPGROUND	MO5241443	125	SUMMER CAMP	4 /1	12/31
	THE LAKE HOUSE	MO5282679	55	OTHER TRANSIENT AREA	1 /1	12/31
	THE PENINSULA SUBD	MO5252641	90	RESIDENTIAL AREA	1 /1	12/31
	THE ROCKS LAKESIDE GRILL AND LOUNGE	MO5212501	200	RESTAURANT	1 /1	12/31
	TRIBESMAN RESORT	MO5190994	650	HOTEL/MOTEL	3 /1	12/31
	USACE TABLE ROCK AUNTS CREEK	MO5111969	160	RECREATION AREA	5 /1	9 /30
	USACE TABLE ROCK BAXTER PARK	MO5111966	160	RECREATION AREA	5 /1	9 /30
	USACE TABLE ROCK CAMPBELL POINT 126	MO5110280	630	RECREATION AREA	4 /1	10/31
	USACE TABLE ROCK CAPE FAIR	MO5110097	240	RECREATION AREA	4 /1	10/31
	USACE TABLE ROCK INDIAN POINT	MO5111944	750	RECREATION AREA	4 /1	10/31
	USACE TABLE ROCK OLD HWY 86	MO5110077	120	RECREATION AREA	4 /1	10/31
	VILLAGE AT INDIAN POINT	MO5191453	90	HOTEL/MOTEL	1 /1	12/31
	WAGNERS ONE STOP	MO5290224	400	SERVICE STATION	1 /1	12/31
	WHISPERING WOODS	MO5190998	32	HOTEL/MOTEL	3 /1	12/31
	WHITE OAK STATION # 6	MO5258122	47	SERVICE STATION	1 /1	12/31
	WHITE RIVER LANDING	MO5201007	25	RECREATION AREA	3 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
STONE	WHITE WING RESORT	MO5190962	40	HOTEL/MOTEL	4 /1	11/30
	Y 76 HANDI MART	MO5290227	50	OTHER TRANSIENT AREA	1 /1	12/31
SULLIVAN	SMITHFIELD FARMLAND CORP	MO2181076	1200	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
TANEY	AMERICAS BEST CMPGRND	MO5201414	450	RECREATION AREA	4 /15	12/31
	BASS PRO SHOPS LONG CREEK MARINA	MO5233029	50	OTHER TRANSIENT AREA	4 /1	10/31
	BIG BEAR ESTATES POA	MO5252920	35	SECONDARY RESIDENCES	1 /1	12/31
	BIG CEDAR LODGE RESORT	MO5191011	2440	HOTEL/MOTEL	1 /1	12/31
	BLUE HAVEN RESORT	MO5191016	100	HOTEL/MOTEL	1 /1	12/31
	BRADLEYVILLE R I SCHOOL	MO5171231	285	SCHOOL	1 /1	12/31
	BRANSON AIRPORT LLC	MO5221580	25	OTHER NON-TRANSIENT AREA	1 /1	12/31
	BRANSON AT EASE RV PARK	MO5241250	20	RECREATION AREA	5 /1	10/31
	BRANSON CEDARS RESORT	MO5282768	25	OTHER TRANSIENT AREA	1 /1	12/31
	BRANSON REC PLEX	MO5202738	350	RECREATION AREA	1 /1	12/31
	BRANSON STAGECOACH	MO5240231	46	SUMMER CAMP	1 /1	12/31
	BRANSON VIEW CAMPGROUND	MO5242442	100	RECREATION AREA	1 /1	12/31
	CEDARCREEK CONVENIENCE STORE	MO5293211	25	OTHER TRANSIENT AREA	1 /1	12/31
	CLIFFS AT LONG CREEK	MO5031498	200	RESIDENTIAL AREA	1 /1	12/31
	COOPER CREEK RESORT	MO5191022	200	HOTEL/MOTEL	1 /1	12/31
	D MONACO LUXURY RESORT AND RESTAURANT	MO5212783	25	RESTAURANT	1 /1	12/31
	DOLLAR GENERAL #16542	MO5283203	25	OTHER TRANSIENT AREA	1 /1	12/31
	DRIFTWATER RESORT LLC	MO5191015	45	HOTEL/MOTEL	4 /1	9 /30
	EDGEWATER BEACH RESORT	MO5191004	25	HOTEL/MOTEL	1 /1	12/31
	EMPIRE DIST ELEC OZARK BEACH	MO5280562	25	OTHER TRANSIENT AREA	4 /1	10/31
	GATEWAY TO BRANSON EXPRESS STOP	MO5292590	25	SERVICE STATION	1 /1	12/31
	GDM INVESTMENT PROJECT	MO5182954	25	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	HAPPY HOLLOW RESORT	MO5191013	50	HOTEL/MOTEL	3 /3	11/30
	HOLLISTER RV SCHOOL DISTRICT AG BLDG	MO5163162	120	SCHOOL	1 /1	12/31
	KANAKUK K KAUAI	MO5242626	250	RECREATION AREA	1 /1	12/31
	KANAKUK KAMP NO 1	MO5248293	440	OTHER NON-TRANSIENT AREA	1 /1	12/31
	LAKE SHORE RESORT LLC	MO5191757	65	HOTEL/MOTEL	1 /1	12/31
	LAZY VALLEY RESORT	MO5191029	60	HOTEL/MOTEL	4 /1	10/31
	LIFE CHRISTIAN CENTER	MO5273121	80	OTHER TRANSIENT AREA	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
TANEY	LILLEYS LANDING RESORT	MO5191989	92	HOTEL/MOTEL	1 /1	12/31
	LOGGERS ASSN	MO5031174	25	SUBDIVISION	1 /1	12/31
	MARK TWAIN R VIII ELEMENTARY SCHOOL	MO5171233	80	SCHOOL	1 /1	12/31
	MISSOURI RIDGE DISTILLERY	MO5283168	25	OTHER TRANSIENT AREA	1 /1	12/31
	NATIONAL INSTITUTE OF MARRIAGE	MO5283154	25	OTHER TRANSIENT AREA	1 /1	12/31
	PEACE LUTHERAN CHURCH	MO5283051	50	OTHER TRANSIENT AREA	1 /1	12/31
	PINE VALLEY	MO5191610	55	HOTEL/MOTEL	1 /1	12/31
	RAPID ROBERTS 104	MO5258138	800	SERVICE STATION	1 /1	12/31
	RAPID ROBERTS 121	MO5292575	25	SERVICE STATION	1 /1	12/31
	ROCK VIEW RESORT	MO5191535	35	HOTEL/MOTEL	1 /1	12/31
	ROYAL OAK ENTERPRISES INC	MO5180639	44	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	SCOOPS & MORE	MO5211245	150	RESTAURANT	4 /1	11/30
	SCOTTYS HITCH N POST	MO5211978	25	SERVICE STATION	1 /1	12/31
	SENIOR FRIENDSHIP SITE	MO5218056	75	RESTAURANT	1 /1	12/31
	SHEPHERD OF THE HILLS	MO5211955	1000	RECREATION AREA	1 /1	12/31
	SHEPHERD OF THE HILLS HATCHERY	MO5142186	25	RECREATION AREA	1 /1	12/31
	TABLE ROCK STATE PARK	MO5120169	500	RECREATION AREA	1 /1	12/31
	TANEY COUNTY MEMORIAL POST 5168	MO5218299	60	RESTAURANT	1 /1	12/31
	TANEYCOMO LAKEFRONT RESORT	MO5191032	75	HOTEL/MOTEL	1 /1	12/31
	TANGLEWOOD LODGE	MO5191030	45	HOTEL/MOTEL	4 /1	10/31
	THE DINNER BELL	MO5212699	25	RESTAURANT	1 /1	12/31
	TONYS PIZZA	MO5212926	25	RESTAURANT	1 /1	12/31
	TOP OF THE ROCK GOLF COURSE	MO5202075	25	RECREATION AREA	1 /1	12/31
	TROPHY RUN ESTATES	MO5240069	25	OTHER TRANSIENT AREA	1 /1	12/31
	TROUT HOLLOW LODGE	MO5191018	75	HOTEL/MOTEL	1 /1	12/31
	USACE BASS PRO SHOPS LONG CREEK CAMPGRD	MO5111998	135	RECREATION AREA	5 /1	9 /30
	USACE TABLE ROCK RESIDENT OFFICE	MO5110030	175	RECREATION AREA	1 /1	12/31
	VICKERY RESORT CONDOMINIUMS	MO5191008	80	HOTEL/MOTEL	4 /1	9 /30
	WHITE OAK STATION # 21	MO5292355	25	OTHER TRANSIENT AREA	1 /1	12/31
	WILD BILLS TRAVEL CENTER	MO5292494	25	SERVICE STATION	1 /1	12/31
TEXAS	BIG CREEK CHURCH	MO4273027	70	OTHER TRANSIENT AREA	1 /1	12/31
	CABOOL SECOND BAPTIST CHURCH & DAYCARE	MO4272906	200	DAY CARE CENTER	1 /1	12/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
TEXAS	GARDENS INN	MO4211081	150	RESTAURANT	1 /1	12/31
	TWIN CITIES INDUSTRIAL CORRIDOR INC	MO4181541	50	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
WARREN	CEDAR LAKE CELLARS	MO6213062	50	RESTAURANT	1 /1	12/31
	DOGWOOD LAKE CAMPGROUND INTERN	MO6241431	200	SUMMER CAMP	4 /1	10/31
	FLYING J TRAVEL PLAZA	MO6182070	100	SERVICE STATION	1 /1	12/31
	LAKE CREEK FARM WINERY	MO6213210	25	RESTAURANT	1 /1	12/31
	ST IGNATIUS LOYOLA SCHOOL	MO6172414	50	SCHOOL	1 /1	12/31
	WARCO MFG COMPANY	MO6180571	32	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	WASHINGTON AIRPORT	MO6220265	25	OTHER TRANSIENT AREA	1 /1	12/31
WASHINGTON	B AND M QUICKSTOP	MO4293198	550	OTHER TRANSIENT AREA	1 /1	12/31
	BATES CREEK BAPTIST CAMP	MO4228500	100	OTHER TRANSIENT AREA	4 /1	10/31
	BRI CO INC	MO4258547	50	OTHER TRANSIENT AREA	1 /1	12/31
	BUCKMAN NORTH AMERICA CADET PLANT	MO4180243	30	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	DOE RUN COMPANY VIBURNUM 29	MO6180586	28	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	DOLLAR GENERAL #15600 WASHINGTON COUNTY	MO4283167	350	RETAIL EMPLOYEES	1 /1	12/31
	FOURCHE VALLEY GOLF CLUB	MO4201034	107	RECREATION AREA	1 /1	12/31
	HOT SHOTS	MO4283114	25	RESTAURANT	1 /1	12/31
	KINGSTON K 14 SCHOOL PRIMARY	MO4172516	450	SCHOOL	1 /1	12/31
	LITTLE LEARNERS ACADEMY	MO4173065	46	DAY CARE CENTER	1 /1	12/31
	POTOSI R III SCHOOLS BALLFIELD COMPLEX	MO4172863	25	RECREATION AREA	1 /1	12/31
	REED LUMBER COMPANY LLC	MO6180585	50	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	RICHWOODS ELEMENTARY SCHOOL	MO6171238	175	SCHOOL	1 /1	12/31
	ROYS NUMBER ONE	MO4292853	400	SERVICE STATION	1 /1	12/31
	ST JOACHIM SCHOOL	MO4172753	66	SCHOOL	1 /1	12/31
	STARLITE DRIVE IN THEATRE	MO4218505	100	RESTAURANT	1 /1	12/31
	WASHINGTON COUNTY KNIGHTS OF COLUMBUS	MO4283058	100	OTHER TRANSIENT AREA	1 /1	12/31
	WASHINGTON STATE PARK CAMPGROUND	MO6123123	125	RECREATION AREA	4 /1	11/30
	WASHINGTON STATE PARK OFFICE	MO6120173	125	RECREATION AREA	1 /1	12/31
	YMCA OZARKS EAST CAMP	MO4241051	650	SUMMER CAMP	6 /6	8 /31
	YMCA OZARKS SPRING	MO4191055	1000	HOTEL/MOTEL	1 /1	12/31
WAYNE	CAMP CHEROKEE RIDGE	MO4241707	500	SUMMER CAMP	4 /1	10/31
	CAMP LEWALLEN BSA	MO4240283	300	SUMMER CAMP	4 /15	10/31

Noncommunity Water Systems

County	Water System Name	ID Number	Population	System Type	Date Season Begins	Date Season Ends
WAYNE	CLEARWATER LAKE RESORT	MO4198091	35	HOTEL/MOTEL	5 /23	9 /30
	CLEARWATER STORES INC	MO4231417	25	RESTAURANT	4 /1	10/31
	EAGLE SKY OF THE OZARKS	MO4242939	25	SUMMER CAMP	1 /1	12/31
	LAKE WAPPAPELLO STATE PARK	MO4120161	268	RECREATION AREA	1 /1	12/31
	USACE CAMP LATONKA	MO4242211	180	SUMMER CAMP	4 /1	10/31
	USACE CAMP SEMO WAPPAPELLO	MO4241970	60	RECREATION AREA	4 /1	11/30
	USACE CLEARWATER RIVER RD LEFT BK 10	MO4112030	600	RECREATION AREA	3 /15	10/31
	USACE CLEARWATER RIVER RD RIGHT 18C	MO4112032	50	RECREATION AREA	3 /15	10/31
	USACE WAPPAPELLO RES CHAONIA CAMP	MO4110115	250	RECREATION AREA	1 /1	12/31
	USACE WAPPAPELLO RES HOLLIDAY LANDING	MO4112033	500	RECREATION AREA	1 /1	12/31
	USACE WAPPAPELLO RES OLD GREENVILLE	MO4112213	150	RECREATION AREA	1 /1	12/31
	USFS MARKHAM SPRING	MO4100019	164	RECREATION AREA	5 /1	9 /30
WEBSTER	BILLS QUICK MART	MO5258130	100	SUBDIVISION	1 /1	12/31
	DIGGINS APOSTOLIC CHURCH	MO5272948	90	OTHER TRANSIENT AREA	1 /1	12/31
	FRATERNAL ORDER OF BEARS # 27	MO5213087	30	RESTAURANT	1 /1	12/31
	HANNAHS GENERAL STORE	MO5290233	25	OTHER TRANSIENT AREA	1 /1	12/31
	MO ST FREE WILL BAPTIST YOUTH CAMP	MO5248115	300	RECREATION AREA	6 /1	7 /31
	MODOT I 44 REST AREA CONWAY	MO5130529	500	HIGHWAY REST AREA	1 /1	12/31
	PARADISE IN THE WOODS RV PARK	MO5192893	30	RECREATION AREA	1 /1	12/31
	SHO ME POWER ELECTRIC COOP	MO5182899	45	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	TIMBER RIDGE BAPTIST CHURCH	MO5273091	120	OTHER TRANSIENT AREA	1 /1	12/31
	UNDERCOVER TRUCK BED COVERS	MO5183137	200	OTHER NON-TRANSIENT AREA	1 /1	12/31
	WILD ANIMAL SAFARI INC	MO5208114	325	RECREATION AREA	1 /1	12/31
	XP0 LOGISTICS	MO5182621	132	OTHER TRANSIENT AREA	1 /1	12/31
WRIGHT	BAKER CREEK HEIRLOOM SEED CO	MO5183025	35	INDUSTRIAL/AGRICULTURAL	1 /1	12/31
	CLUB 60 RESTAURANT LLC	MO5218312	42	RESTAURANT	1 /1	12/31
	MANES R V ELEMENTARY SCHOOL	MO5171242	70	SCHOOL	1 /1	12/31
	MOUNTAIN GROVE MENNONITE CHURCH & SCHOOL	MO5172799	150	SCHOOL	1 /1	12/31

V. COMMUNITY/NONCOMMUNITY WATER TREATMENT INFORMATION

COMMUNITY/NONCOMMUNITY WATER TREATMENT INFORMATION INTRODUCTION

The Community/Noncommunity Water Treatment Information section contains a complete listing of all water systems and the types of treatment processes performed in order to maintain a high quality of water for the citizens of Missouri. This list is done alphabetically by water system.

System Treatment Processes

MO5031436
10 4 WATER SYSTEM
- FILTRATION, CARTRIDGE

MO3238020
11 WEST CONDOMINIUM
- ION EXCHANGE

MO3292542
17 EAGLE STOP
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5231809
3V CORP
- FILTRATION, CARTRIDGE
- ULTRAVIOLET RADIATION

MO5292984
7 EXPRESS
- ION EXCHANGE

MO5258147
86 SUPER STOP LLC
- FILTRATION, CARTRIDGE

MO1041099
A LITTLE OFF BASE
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SPRAY
- HYPOCHLORINATION, POST

MO5252577
ABC WATER ASSN
- HYPOCHLORINATION, POST

MO6202688
ABERDEEN GOLF CLUB
- ION EXCHANGE

MO1272844
ABUNDANT LIFE CHRISTIAN CHURCH
- FILTERED
- ION EXCHANGE

MO1010001
ADRIAN PWS
- ACTIVATED CARBON, POWDERED
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO4010002
ADVANCE PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO5031627
AIRPARK BEACH
- HYPOCHLORINATION, POST

MO5031435
AIRPORT HOMEOWNERS ASSN INC
- HYPOCHLORINATION, POST

MO5238288
AIRPORT VILLAGE MHP
- FILTRATION, GREENSAND
- HYPOCHLORINATION, POST

MO5180614
AJINOMOTO WINDSOR
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO1010006
ALBANY PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- RAPID MIX
- SEDIMENTATION

MO6040116
ALLEN ACRES
- HYPOCHLORINATION, POST

System Treatment Processes

MO5293126
ALPS GROCERY PITTSBURG
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO4010011
ALTENBURG PWS
- HYPOCHLORINATION, POST

MO4010012
ALTON PWS
- HYPOCHLORINATION, PRE

MO3182219
AMEREN MISSOURI CALLAWAY ENERGY CENTER
- HYPOCHLORINATION, POST

MO6182217
AMEREN U E RUSH ISLAND
- ION EXCHANGE

MO5250889
AMERICAN RESORTS HOA
- HYPOCHLORINATION, POST

MO3281196
AMERICAN VETERANS POST 108
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5282846
AMERICAN VETERANS POST 116
- HYPOCHLORINATION, POST

MO5201414
AMERICAS BEST CMPGRND
- HYPOCHLORINATION, POST

MO5010016
ANDERSON PWS
- GASEOUS CHLORINATION, POST

MO5250537
ANGLERS BEND UNIT 2
- HYPOCHLORINATION, POST

MO1242707
ANGLERS RETREAT RV PARK
- HYPOCHLORINATION, POST

MO4010017
ANNAPOLIS PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, PRE
- SEDIMENTATION

MO4010022
ARBYRD PWS
- HYPOCHLORINATION, POST

MO4010023
ARCADIA PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO1010024
ARCHIE PWS
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5261253
AREA 71 LLC
- HYPOCHLORINATION, POST

MO5010027
ARROW POINT VILLAGE PWS
- HYPOCHLORINATION, POST

MO5190987
ARROWHEAD NAVAJO WELLOWNERS ASSOCIATION
- HYPOCHLORINATION, POST

MO3010033
ASHLAND PWS
- GASEOUS CHLORINATION, POST

System Treatment Processes

MO2182290
ASSOCIATED ELECTRIC THOMAS HILL 3

- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO1021595
ATCHISON COUNT WHOLESALE WATER COMMISSIO

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- CHLORAMINES
- FILTRATION, RAPID SAND
- HYPOCHLORINATION, POST
- LIME - SODA ASH ADDITION

MO3172256
AUNT MARTHAS PRESCHOOL & DAY CARE

- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO5041140
AUNTS CREEK DEV 1ST ADD

- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5258123
AUNTS CREEK RV PARK & STORE

- HYPOCHLORINATION, POST

MO5010038
AURORA VERONA

- HYPOCHLORINATION, POST

MO1243176
AUSTINS PLACE

- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO3010039
AUXVASSE PWS

- GASEOUS CHLORINATION, POST

MO5172986
AVA HEAD START

- HYPOCHLORINATION, PRE

MO5171181
AVILLA ELEMENTARY SCHOOL

- HYPOCHLORINATION, POST

MO4293198
B AND M QUICKSTOP

- ULTRAVIOLET RADIATION

MO6120147
BABLER STATE PARK

- HYPOCHLORINATION, POST

MO6069045
BAISCH NURSING CENTER

- ION EXCHANGE

MO5011066
BAKERSFIELD PWS

- HYPOCHLORINATION, POST

MO6213173
BALDUCCI VINEYARDS

- ION EXCHANGE

MO5241754
BALLARDS CAMPGROUND

- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO4069075
BAPTIST HOME

- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5191678
BAR M RESORT & CAMPGROUND

- HYPOCHLORINATION, POST
- ION EXCHANGE

MO3010047
BARNETT PWS

- HYPOCHLORINATION, POST

MO5036196
BARRY COUNTY PWSD 2

- HYPOCHLORINATION, POST

System Treatment Processes

MO5024023
BARTON DADE CEDAR JASP COUNTYCONS PWSD 1
- GASEOUS CHLORINATION, POST

MO5233029
BASS PRO SHOPS LONG CREEK MARINA
- HYPOCHLORINATION, POST

MO1024031
BATES COUNTY PWSD 2
- CHLORAMINES
- COAGULATION
- FILTRATION, ULTRAFILTRATION
- FLOCCULATION
- HYPOCHLORINATION, POST
- PH ADJUSTMENT, POST
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO4228500
BATES CREEK BAPTIST CAMP
- HYPOCHLORINATION, POST

MO5292361
BAUMERS FOOD MART
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5190935
BAVARIAN VILLAGE RESORT
- FILTRATION, CARTRIDGE

MO3238034
BAY POINT VILLAGE CONDO
- ION EXCHANGE

MO3190958
BAYMONT INN & SUITES
- ION EXCHANGE

MO3238271
BAYWOOD CONDOMINIUM
- ION EXCHANGE

MO5241246
BEAGLE BAY RV HAVEN & CAMPGROUND
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3192316
BEAUTY VIEW RESORT
- HYPOCHLORINATION, POST

MO4010052
BELL CITY PWS
- 4-LOG TREATMENT OF VIRUSES
- GASEOUS CHLORINATION, PRE

MO4069040
BELLEVIEW VALLEY NURSING HOME
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6010058
BELLFLOWER PWS
- HYPOCHLORINATION, POST

MO5031454
BENDCO COVE
- HYPOCHLORINATION, POST

MO5120148
BENNETT SPRING STATE PARK WELL 1
- HYPOCHLORINATION, POST

MO5122657
BENNETT SPRING STATE PARK WELL 2
- HYPOCHLORINATION, POST

MO5122658
BENNETT SPRING STATE PARK WELL 3
- HYPOCHLORINATION, POST

MO5240034
BENNETT SPRINGS CAMPGROUND 1
- HYPOCHLORINATION, POST

MO5213059
BENTLEYS RESTAURANT
- ION EXCHANGE

MO4010062
BENTON PWS
- HYPOCHLORINATION, POST

System Treatment Processes

MO4010066
BERNIE PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, DIFFUSED
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- SEDIMENTATION

MO4010067
BERTRAND PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO1010068
BETHANY PWS
- ACTIVATED CARBON, POWDERED
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5252920
BIG BEAR ESTATES POA
- HYPOCHLORINATION, POST

MO5191011
BIG CEDAR LODGE RESORT
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO4242940
BIG CREEK RV PARK
- HYPOCHLORINATION, POST

MO3031265
BIG ISLAND WATER COMPANY
- ION EXCHANGE

MO5242916
BIG RED BARN RV PARK
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4036173
BIG RIVER HILLS LLC
- HYPOCHLORINATION, PRE

MO6041162
BIG VALLEY COURT
- ACTIVATED CARBON, GRANULAR
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5048225
BIG VALLEY PARK MHP
- HYPOCHLORINATION, POST

MO5010071
BILLINGS PWS
- HYPOCHLORINATION, POST

MO4218555
BILLS PLACE
- ION EXCHANGE

MO5258130
BILLS QUICK MART
- FILTERED

MO4010072
BIRCH TREE PWS
- GASEOUS CHLORINATION, POST

MO4258537
BIXBY COUNTRY STORE
- HYPOCHLORINATION, PRE

MO3031167
BLACK FOREST HOA INC NO 2
- HYPOCHLORINATION, POST

MO5036267
BLACK OAK WATER & SEWER CO
- HYPOCHLORINATION, POST

System Treatment Processes

MO4190874
BLACK RIVER LODGE INC
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO6010077
BLAND PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- GASEOUS CHLORINATION, POST

MO4011179
BLODGETT PWS
- 4-LOG TREATMENT OF VIRUSES
- FILTRATION, GREENSAND
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, POST
- PERMANGANATE
- SEQUESTRATION

MO4010078
BLOOMFIELD PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- SEDIMENTATION

MO5252708
BLUE CAT POINT
- FILTRATION, CARTRIDGE
- ULTRAVIOLET RADIATION

MO5191016
BLUE HAVEN RESORT
- FILTERED
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5240219
BLUE MOUNTAIN CAMPGROUND
- HYPOCHLORINATION, POST

MO5031298
BLUE RIDGE ESTATES SUBD
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5031128
BLUE WATER VILLAGE/ BLAKEWOOD SUBD
- HYPOCHLORINATION, POST

MO1010084
BOLCKOW PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5222460
BOLIVAR MUNICIPAL AIRPORT
- HYPOCHLORINATION, POST

MO5010085
BOLIVAR PWS
- GASEOUS CHLORINATION, POST

MO4010422
BOLLINGER COUNTY PWSD 1
- HYPOCHLORINATION, PRE

MO5258076
BOLTONS GENERAL STORE
- FILTRATION, CARTRIDGE
- ULTRAVIOLET RADIATION

MO4061410
BONNE TERRE PRISON
- GASEOUS CHLORINATION, PRE
- ION EXCHANGE

MO4010087
BONNE TERRE PWS
- GASEOUS CHLORINATION, POST

MO3024055
BOONE COUNTY CONS PWSD 1
- GASEOUS CHLORINATION, POST

MO3024059
BOONE COUNTY PWSD 10
- GASEOUS CHLORINATION, POST

MO3024052
BOONE COUNTY PWSD 4
- GASEOUS CHLORINATION, POST

System Treatment Processes

MO3024058
BOONE COUNTY PWSD 9
- GASEOUS CHLORINATION, POST

MO6201486
BOONE VALLEY GOLF CLUB
- FILTRATION, GREENSAND
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO3010089
BOONVILLE PWS
- ACTIVATED CARBON, POWDERED
- AERATION, SLAT TRAY
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PERMANGANATE
- PH ADJUSTMENT, POST
- RAPID MIX
- SEDIMENTATION
- ULTRAVIOLET RADIATION

MO2010091
BOSWORTH PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO3120151
BOTHWELL LODGE STATE HISTORIC SITE
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO2010093
BOWLING GREEN PWS
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT
- RAPID MIX
- SEDIMENTATION

MO5171231
BRADLEYVILLE R I SCHOOL
- HYPOCHLORINATION, POST

MO5281373
BRAMBLEWOOD GROUP HOME
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5221580
BRANSON AIRPORT LLC
- HYPOCHLORINATION, POST

MO5282768
BRANSON CEDARS RESORT
- HYPOCHLORINATION, POST

MO5031223
BRANSON CREEK DEVELOPMENT LLC
- HYPOCHLORINATION, POST

MO5010096
BRANSON PWS
- ACTIVATED CARBON, POWDERED
- ALGAE CONTROL
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

System Treatment Processes

MO5202738
BRANSON REC PLEX
- HYPOCHLORINATION, POST

MO5240231
BRANSON STAGECOACH
- FILTERED
- HYPOCHLORINATION, POST

MO5240732
BRANSON TREEHOUSE ADVENTURES
- HYPOCHLORINATION, POST

MO5242442
BRANSON VIEW CAMPGROUND
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5041212
BRANSON VIEW ESTATES
- HYPOCHLORINATION, POST

MO5010158
BRANSON WEST PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO1010098
BRAYMER PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- FLOCCULATION
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- SEDIMENTATION

MO5273217
BREAD OF LIFE SLAVIC CHURCH
- ION EXCHANGE

MO4258547
BRI CO INC
- HYPOCHLORINATION, POST

MO5031104
BRIAR CLIFF SUBDIVISION
- HYPOCHLORINATION, POST

MO5301550
BRIARWOOD & REDBUD SHORES WATER ASSOC
- HYPOCHLORINATION, POST

MO3212409
BRIDAL CAVE DEVELOPMENT COMPANY INC
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5031420
BRIDGEPORT 1ST ADDITION
- FILTRATION, CARTRIDGE
- ULTRAVIOLET RADIATION

MO5210659
BRIDGEWAY PLAZA SHOPPING CENTER
- HYPOCHLORINATION, POST

MO5283052
BRIGHTON ASSEMBLY OF GOD
- HYPOCHLORINATION, POST

MO6202782
BROEMMELSIEK PARK
- HYPOCHLORINATION, POST

MO5010104
BRONAUGH PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

System Treatment Processes

MO2010105
BROOKFIELD PWS
ACTIVATED CARBON, POWDERED
AERATION, SLAT TRAY
CHLORAMINES
COAGULATION
FILTRATION, RAPID SAND
FLOCCULATION
FLUORIDATION
GASEOUS CHLORINATION, POST
GASEOUS CHLORINATION, PRE
LIME - SODA ASH ADDITION
PERMANGANATE
PH ADJUSTMENT, PRE
RAPID MIX
SEDIMENTATION

MO3079510
BROOKVIEW APARTMENTS
4-LOG TREATMENT OF VIRUSES
HYPOCHLORINATION, POST

MO4181392
BUCHHEIT INC
HYPOCHLORINATION, POST
ION EXCHANGE

MO4180243
BUCKMAN NORTH AMERICA CADET PLANT
HYPOCHLORINATION, PRE
ION EXCHANGE

MO3190893
BUDGET HOST SUPER 7 MOTEL
ION EXCHANGE

MO3190887
BUDGET INN
HYPOCHLORINATION, PRE
ION EXCHANGE

MO5272955
BUFFALO CREEK BAPTIST CHURCH
FILTRATION, GREENSAND
HYPOCHLORINATION, POST
ION EXCHANGE

MO5010114
BUFFALO PWS
HYPOCHLORINATION, POST

MO5048161
BULL CREEK VILLAGE
HYPOCHLORINATION, POST

MO5293002
BULLSEYE 34
FILTRATION, CARTRIDGE

MO5291060
BULLSEYE 37
ION EXCHANGE
PH ADJUSTMENT
ULTRAVIOLET RADIATION

MO4190279
BUNKER HILL RANCH
HYPOCHLORINATION, POST

MO3192338
BUNKHOUSE LODGE
ION EXCHANGE

MO3180619
BURGERS OZARK COUNTRY CURED HAMS
FILTRATION, CARTRIDGE
ION EXCHANGE

MO1010117
BURLINGTON JUNCTION PWS
ACTIVATED CARBON, GRANULAR
FILTRATION, GREENSAND
HYPOCHLORINATION, POST
HYPOCHLORINATION, PRE
PERMANGANATE

MO2172980
BUSY BEE LEARNING ACADEMY
ION EXCHANGE

MO4024070
BUTLER COUNTY PWSD 1
4-LOG TREATMENT OF VIRUSES
GASEOUS CHLORINATION, POST

System Treatment Processes

MO4024072
BUTLER COUNTY PWSD 3
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO1010118
BUTLER PWS
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5010119
BUTTERFIELD PWS
- HYPOCHLORINATION, POST

MO5031125
BUTTERMILK SPRINGS WATER ASSN
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5272301
BYKOTA CHURCH
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5292823
C MART
- HYPOCHLORINATION, POST

MO5212698
C SITE BAR & GRILL
- ION EXCHANGE

MO4010120
CABOOL PWS
- 4-LOG TREATMENT OF VIRUSES
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- HYPOCHLORINATION, POST

MO1024078
CALDWELL COUNTY PWSD 1
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PERMANGANATE
- PH ADJUSTMENT

MO3010124
CALIFORNIA PWS
- FLUORIDATION
- GASEOUS CHLORINATION, POST

MO3024085
CALLAWAY 2 WATER DISTRICT
- GASEOUS CHLORINATION, POST

MO3024084
CALLAWAY COUNTY PWSD 1
- GASEOUS CHLORINATION, POST

MO5191312
CALM WATERS RESORT
- ION EXCHANGE

MO5273082
CALVARY CHAPEL LAKE OF THE OZARKS
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO3031383
CAMDEN COUNTY PWSD # 5 CEDAR HEIGHTS
- HYPOCHLORINATION, POST

MO3302557
CAMDEN COUNTY PWSD # 5 CLEARWATER CONDOS
- HYPOCHLORINATION, POST

MO3031201
CAMDEN COUNTY PWSD #4 SHAWNEE BEND
- GASEOUS CHLORINATION, POST

System Treatment Processes

MO5021438
CAMDEN COUNTY PWSD 3
- HYPOCHLORINATION, POST

MO3021377
CAMDEN COUNTY PWSD 4 HORSESHOE BEND
- FLUORIDATION
- GASEOUS CHLORINATION, POST

MO1010131
CAMERON PWS
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO3241749
CAMP BAGNELL
- FILTRATION, CARTRIDGE
- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO5242436
CAMP BARNABAS ON TABLE ROCK LAKE
- HYPOCHLORINATION, POST

MO1272873
CAMP BRANCH BAPTIST CHURCH
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO4190281
CAMP BUTTERFLY
- HYPOCHLORINATION, PRE

MO6240040
CAMP CEDARLEDGE
- ION EXCHANGE

MO5228141
CAMP FINBROOKE
- HYPOCHLORINATION, POST

MO5243080
CAMP HEBRON
- HYPOCHLORINATION, POST

MO3248239
CAMP HERITAGE
- ION EXCHANGE

MO4240283
CAMP LEWALLEN BSA
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3240249
CAMP MIHASKA
- ION EXCHANGE

MO6242645
CAMP TRINITY
- ION EXCHANGE

MO6240045
CAMP TUCKAHO
- HYPOCHLORINATION, PRE

MO5248289
CAMP WAKONDA
- HYPOCHLORINATION, POST

MO5243072
CAMPBELL POINT MARINA
- FILTERED
- HYPOCHLORINATION, POST

MO4010132
CAMPBELL PWS
- HYPOCHLORINATION, POST

System Treatment Processes

MO2010134
CANTON PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5031303
CANYON FOREST EAST AND WEST

- HYPOCHLORINATION, POST

MO5031343
CAPE FAIR ESTATES

- HYPOCHLORINATION, POST

MO4024097
CAPE GIRARDEAU COUNTY PWSD 2

- HYPOCHLORINATION, POST

MO4021532
CAPE GIRARDEAU COUNTY PWSD 5

- HYPOCHLORINATION, POST

MO4010136
CAPE GIRARDEAU PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- AERATION, SLAT TRAY
- CHLORAMINES
- COAGULATION
- FILTRATION, GREENSAND
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PERMANGANATE
- PH ADJUSTMENT
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION
- SEQUESTRATION

MO4024096
CAPE PERRY COUNTY PWSD 1 SOUTH

- 4-LOG TREATMENT OF VIRUSES
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE

MO5031172
CAPS COVE SUBD

- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3218029
CARDINAL COVE

- ION EXCHANGE

MO5192432
CARDINAL HILL COTTAGES

- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO4010137
CARDWELL PWS

- HYPOCHLORINATION, POST

MO5010138
CARL JUNCTION PWS

- 4-LOG TREATMENT OF VIRUSES
- GASEOUS CHLORINATION, POST

MO4031320
CAROLINA OAKS PLANTATION

- HYPOCHLORINATION, PRE
- OZONATION, PRE

MO5258134
CARR LANE COUNTRY STOP

- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

System Treatment Processes

MO2024105
CARROLL COUNTY PWSD 1

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT

MO2010140
CARROLLTON PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- RAPID MIX
- SEDIMENTATION

MO4024108
CARTER COUNTY PWSD 1

- HYPOCHLORINATION, POST

MO4024109
CARTER COUNTY PWSD 2

- HYPOCHLORINATION, POST

MO5010141
CARTERVILLE PWS

- HYPOCHLORINATION, POST

MO5010142
CARTHAGE PWS

- 4-LOG TREATMENT OF VIRUSES
- CHLORAMINES
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- SEDIMENTATION

MO4010143
CARUTHERSVILLE PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT
- REDUCING AGENT, SULFUR DIOXIDE
- SEDIMENTATION

MO5258125
CASES CORNER

- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO1024111
CASS COUNTY PWSD 7

- ACTIVATED CARBON, POWDERED
- COAGULATION
- FILTRATION, RAPID SAND
- FILTRATION, ULTRAFILTRATION
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5010144
CASSVILLE PWS

- GASEOUS CHLORINATION, POST

MO6291625
CASTLES GROCERY AND CAFE

- ION EXCHANGE

MO5241680
CASTLEVIEW COUNTRY CLUB

- HYPOCHLORINATION, POST

MO5031136
CATAMOUNT RIDGE PROPERTY OWNERS ASSOC

- HYPOCHLORINATION, POST

System Treatment Processes

MO4283025
CAVE VINEYARD
- ION EXCHANGE

MO5024120
CEDAR COUNTY PWSD 1
- GASEOUS CHLORINATION, POST

MO5031097
CEDAR COVE PARK SUBD
- HYPOCHLORINATION, POST

MO6192601
CEDAR CREEK CONFERENCE CENTER
- ION EXCHANGE

MO3270289
CEDAR GROVE BAPTIST CHURCH
- ACTIVATED CARBON, GRANULAR

MO6292410
CEDAR HILL #508
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO5079527
CEDAR HILL APTS
- HYPOCHLORINATION, POST

MO6213062
CEDAR LAKE CELLARS
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5036048
CEDARIDGE ESTATES
- HYPOCHLORINATION, PRE

MO3010149
CENTERTOWN PWS
- HYPOCHLORINATION, POST

MO5031380
CENTRAL CROSSING ACRES II
- HYPOCHLORINATION, POST

MO3069008
CENTRAL MO CRRCTNL CTR
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3010152
CENTRALIA PWS
- 4-LOG TREATMENT OF VIRUSES
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO3292348
CGS MINIMART
- HYPOCHLORINATION, POST

MO4010154
CHAFFEE PWS
- 4-LOG TREATMENT OF VIRUSES
- FILTRATION, GREENSAND
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT

MO5010968
CHAIN O LAKES VILLAGE PWS
- HYPOCHLORINATION, POST

MO5031553
CHALETS ON TABLE ROCK LAKE
- HYPOCHLORINATION, PRE

MO3010155
CHAMOIS PWS
- HYPOCHLORINATION, POST

MO6282901
CHANDLER HILL VINEYARD
- ION EXCHANGE

MO5190909
CHAPEL HILL SUBD
- HYPOCHLORINATION, POST

System Treatment Processes

MO4010160
CHARLESTON PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, DIFFUSED
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO1212915
CHARLEYS BUFFET
- ION EXCHANGE

MO6240106
CHEROKEE LAKES CAMP
- HYPOCHLORINATION, POST

MO2010162
CHILLICOTHE MUNICIPAL UTILITIES
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5252736
CHIMNEY POINT ASSN
- FAT PIPE
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO6273193
CHRIST CENTERED CHURCH
- ION EXCHANGE

MO5191413
CHRISTIAN ASSOCIATES OF TABLE ROCK LAKE
- HYPOCHLORINATION, POST

MO5024133
CHRISTIAN COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO2273113
CHURCH OF LATTER DAY SAINTS TIPTON BRANC
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6048106
CIRCLE C MOBILE HOME PARK
- HYPOCHLORINATION, POST

MO3218262
CLARAS NORTH 65 CAFE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO2020421
CLARENCE CANNON WHOLESALE WTR COMM
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PERMANGANATE
- PH ADJUSTMENT, POST
- PH ADJUSTMENT, PRE
- RAPID MIX
- REDUCING AGENTS
- SEDIMENTATION
- SLUDGE TREATMENT

MO2024138
CLARK COUNTY CONS PWSD 1
- 4-LOG TREATMENT OF VIRUSES
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE

MO2010882
CLARK PWS
- HYPOCHLORINATION, POST

MO3010166
CLARKSBURG PWS
- HYPOCHLORINATION, POST

System Treatment Processes

MO2010169
CLARKSVILLE PWS

- 4-LOG TREATMENT OF VIRUSES
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- ION EXCHANGE
- SEDIMENTATION

MO4010170
CLARKTON PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- HYPOCHLORINATION, POST

MO1024143
CLAY COUNTY PWSD 3

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- HYPOCHLORINATION, POST
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5031335
CLEAR COVE LANDING

- HYPOCHLORINATION, POST

MO5036191
CLEAR WATER ACRES SUBD

- FILTERED
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4198091
CLEARWATER LAKE RESORT

- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO4231417
CLEARWATER STORES INC

- HYPOCHLORINATION, POST

MO5240145
CLEVENGER BRANCH MEMBERS CORP

- HYPOCHLORINATION, POST

MO5010175
CLEVER PWS

- HYPOCHLORINATION, POST

MO5031498
CLIFFS AT LONG CREEK

- HYPOCHLORINATION, POST

MO5232259
CLOUD 9 RANCH CLUB INC

- HYPOCHLORINATION, POST

MO5218312
CLUB 60 RESTAURANT LLC

- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO5202945
COACHLIGHT RV PARK

- ION EXCHANGE

MO5048173
COACHLIGHT VILLAGE MHP

- HYPOCHLORINATION, POST

MO5212949
COCONUTS

- ION EXCHANGE

MO3024159
COLE COUNTY PWSD 1

- FLUORIDATION

MO3024160
COLE COUNTY PWSD 2

- FLUORIDATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO3024162
COLE COUNTY PWSD 3

- HYPOCHLORINATION, POST

MO3024163
COLE COUNTY PWSD 4

- FLUORIDATION
- GASEOUS CHLORINATION, POST

MO3171146
COLE R V SCHOOL

- ION EXCHANGE

System Treatment Processes

MO3036260
COLE TURKEY ACRES
- HYPOCHLORINATION, POST

MO6171155
COLEMAN ELEMENTARY SCHOOL
- ION EXCHANGE

MO5069033
COLLEGE OF THE OZARKS
- ACTIVATED CARBON, GRANULAR
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, POST
- LIME - SODA ASH ADDITION
- RAPID MIX
- SEDIMENTATION

MO5212119
COLLINS PILOT 385
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO5010884
COLLINS PWS
- HYPOCHLORINATION, POST

MO5048264
COLONY COVE MHP
- HYPOCHLORINATION, PRE

MO3010181
COLUMBIA PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- CHLORAMINES
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- SEDIMENTATION

MO5240050
COMPTON RIDGE CAMP
- HYPOCHLORINATION, POST

MO1010182
CONCEPTION JUNCTION PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- HYPOCHLORINATION, PRE
- PH ADJUSTMENT
- SEDIMENTATION

MO1010184
CONCORDIA PWS
- ACTIVATED CARBON, POWDERED
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, ULTRAFILTRATION
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5031127
COOL WATER COVE WATER WELL ASSN
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3024170
COOPER COUNTY CONSOLIDATED PWSD # 1
- HYPOCHLORINATION, POST

MO3024169
COOPER COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO5210919
COOPER COVE RESORT
- HYPOCHLORINATION, POST

MO3238111
COPPER RIDGE CONDO
- ION EXCHANGE

System Treatment Processes

MO4036307
CORNER WATER COMPANY
- HYPOCHLORINATION, PRE

MO5190965
COTTAGE RESORT
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4171266
COUCH R 1 SCHOOL
- HYPOCHLORINATION, POST

MO5071593
COUNTRY AIRE APARTMENTS
- HYPOCHLORINATION, POST

MO6030484
COUNTRY ESTATES
- ION EXCHANGE

MO5031294
COUNTRY FARM ESTATES HOA INC
- HYPOCHLORINATION, POST

MO5282971
COUNTRY FRESH MARKET
- HYPOCHLORINATION, POST

MO5258127
COUNTRY JUNCTION STORE
- HYPOCHLORINATION, POST

MO5039093
COUNTRY MEADOWS ESTATES
- HYPOCHLORINATION, POST

MO4030275
COUNTRY VILLAGE ESTATES SUBDIVISION
- HYPOCHLORINATION, POST

MO1243138
COVENANT COVE RV RESORT
- AERATION, CASCADE
- FILTERED
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO5291585
COWBOY CORRAL
- HYPOCHLORINATION, POST

MO1010191
CRAIG PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FLOCCULATION
- HYPOCHLORINATION, PRE
- PERMANGANATE

MO5010192
CRANE PWS
- FLUORIDATION

MO6036037
CRAWFORD COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO6200549
CRESCENT FARMS GOLF CLUB
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5031119
CROOKED TREE SUBDIVISION
- HYPOCHLORINATION, PRE

MO5273127
CROSSROADS BAPTIST CHURCH
- ION EXCHANGE

MO4272826
CROWLEY RIDGE MENNONITE CHURCH & SCHOOL
- ACTIVATED CARBON, GRANULAR
- HYPOCHLORINATION, POST

MO4283124
CROWN VALLEY MICRO BREWERY
- ION EXCHANGE

MO4282793
CROWN VALLEY WINERY
- ION EXCHANGE

MO5031192
CRYSTAL BEACH SUBD
- HYPOCHLORINATION, POST

System Treatment Processes

MO6010198
CRYSTAL CITY PWS

- 4-LOG TREATMENT OF VIRUSES
- COAGULATION
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5031513
CTW WATERWORKS INC

- HYPOCHLORINATION, POST

MO6010200
CUBA PWS

- FLUORIDATION

MO5292380
D DIAMOND TRAVEL PLAZA

- FILTRATION, CARTRIDGE

MO5010202
DADEVILLE PWS

- HYPOCHLORINATION, POST

MO6152912
DANIEL BOONE HOME

- HYPOCHLORINATION, POST

MO1036130
DAVIESS COUNTY PWSD 3

- ACTIVATED CARBON, GRANULAR
- COAGULATION
- FILTRATION, RAPID SAND
- FILTRATION, ULTRAFILTRATION
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, PRE
- RAPID MIX
- SEDIMENTATION
- SLUDGE TREATMENT

MO5240536
DAWT MILL AND CAMPGROUND

- ION EXCHANGE

MO5031473
DD16 POA

- HYPOCHLORINATION, POST

MO5202643
DEER CHASE GOLF

- ION EXCHANGE

MO5031629
DEER MOUNTAIN HEIGHTS

- HYPOCHLORINATION, POST

MO5070683
DEER RUN APTS

- HYPOCHLORINATION, POST

MO5240075
DEER RUN MOTEL

- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3260059
DEER VALLEY PARK

- HYPOCHLORINATION, POST

MO5292389
DEERFIELD CENTRE

- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO4010211
DELTA PWS

- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- HYPOCHLORINATION, POST
- SEDIMENTATION

MO4024196
DENT COUNTY PWSD 1

- HYPOCHLORINATION, POST

MO4171150
DENT PHELPS ELEMENTARY SCHOOL

- ULTRAVIOLET RADIATION

MO4011441
DESLOGE PWS

- GASEOUS CHLORINATION, POST

System Treatment Processes

MO6010213
DESOTO PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO4010216
DEXTER PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, DIFFUSED
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO3181615
DIAMOND PET FOODS
- ION EXCHANGE

MO5010217
DIAMOND PWS
- GASEOUS CHLORINATION, POST

MO4061392
DIANAS BOARDING HOME 2
- HYPOCHLORINATION, POST

MO3218195
DICKIE DOO BAR B QUE
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO5010218
DIGGINS PWS
- HYPOCHLORINATION, POST

MO4180666
DOE RUN COMPANY BRUSHY CREEK
- HYPOCHLORINATION, PRE

MO4180635
DOE RUN COMPANY BUICK SMELTER
- HYPOCHLORINATION, PRE

MO4180580
DOE RUN COMPANY FLETCHER M M
- HYPOCHLORINATION, PRE

MO4181648
DOE RUN COMPANY GLOVER PLANT
- HYPOCHLORINATION, POST

MO4182135
DOE RUN COMPANY SWEETWATER UNIT
- HYPOCHLORINATION, PRE

MO6180586
DOE RUN COMPANY VIBURNUM 29
- HYPOCHLORINATION, PRE

MO4180665
DOE RUN COMPANY VIBURNUM 35
- HYPOCHLORINATION, PRE

MO4182221
DOE RUN COMPANY WEST FORK UNIT
- HYPOCHLORINATION, POST

MO4202634
DOE RUN COUNTRY CLUB
- HYPOCHLORINATION, POST

MO4180634
DOE RUN COUNTY BUICK MINE MILL
- HYPOCHLORINATION, PRE

MO6212591
DOG PRAIRIE TAVERN LLC
- ION EXCHANGE

MO3192351
DOGWOOD ACRES RESORT
- ION EXCHANGE

MO5211553
DOGWOOD CANYON
- HYPOCHLORINATION, POST

MO6241431
DOGWOOD LAKE CAMPGROUND INTERN
- ACTIVATED CARBON, GRANULAR
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5238311
DOGWOOD VALLEY ESTATES
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5283142
DOLLAR GENERAL #15781
- HYPOCHLORINATION, POST

MO5283206
DOLLAR GENERAL #17357 CLIMAX SPRINGS
- FILTRATION, CARTRIDGE

System Treatment Processes

MO5283094
DOLLAR GENERAL #4022
- FILTRATION, CARTRIDGE

MO6283182
DOLLAR GENERAL LONEDELL #14038
- ACTIVATED CARBON, GRANULAR
- FILTRATION, CARTRIDGE
- ULTRAVIOLET RADIATION

MO4010221
DONIPHAN PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5190940
DOOLEY LODGES & RESORT
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5190988
DOUBLE OAK RESORT
- ION EXCHANGE

MO5071632
DOYLE APARTMENTS
- ION EXCHANGE

MO4010226
DUDLEY PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, PRE
- SEDIMENTATION

MO5010227
DUENWEG PWS
- HYPOCHLORINATION, POST

MO5180607
DYNO NOBEL
- GASEOUS CHLORINATION, PRE

MO4031203
EAGLE ESTATES
- HYPOCHLORINATION, POST

MO6190794
EAGLE HURST RANCH
- HYPOCHLORINATION, PRE

MO3202344
EAGLE LANES AND BEAR CREEK VALLEY GC
- ION EXCHANGE

MO5031604
EAGLE RIDGE ESTATES
- HYPOCHLORINATION, POST

MO3031307
EAGLE ROCK SUBDIVISION
- FILTRATION, RAPID SAND

MO4242939
EAGLE SKY OF THE OZARKS
- COAGULATION
- FILTRATION, ULTRAFILTRATION
- FLOCCULATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- RAPID MIX
- SEDIMENTATION

MO5030015
EAGLE WOODS SUBDIVISION
- HYPOCHLORINATION, POST

MO4010235
EAST PRAIRIE PWS
- 4-LOG TREATMENT OF VIRUSES
- FILTRATION, GREENSAND
- GASEOUS CHLORINATION, POST
- PERMANGANATE

MO4243201
ECHO BLUFF STATE PARK BLUFF & PAVILION
- HYPOCHLORINATION, PRE

MO4243200
ECHO BLUFF STATE PARK CAMPGROUND
- HYPOCHLORINATION, PRE

MO4240176
ECHO BLUFF STATE PARK LODGE
- HYPOCHLORINATION, PRE

System Treatment Processes

MO3031267
ECHO VALLEY SUBDIVISION
- HYPOCHLORINATION, POST

MO6011147
ECM WATER & SEWER AUTHORITY FLINT HILL
- GASEOUS CHLORINATION, POST
- SEQUESTRATION

MO3191702
ECONO LODGE
- ION EXCHANGE

MO5191004
EDGEWATER BEACH RESORT
- HYPOCHLORINATION, POST

MO3242467
EDGEWATER RV PARK
- HYPOCHLORINATION, POST

MO5191920
EDGEWATER VILLA RESORT
- ION EXCHANGE

MO5241356
ELK RIVER FLOATS & CAMPGROUND
- HYPOCHLORINATION, POST

MO4010243
ELLINGTON PWS
- 4-LOG TREATMENT OF VIRUSES
- GASEOUS CHLORINATION, POST

MO4010246
ELLSINORE PWS
- HYPOCHLORINATION, POST

MO5031088
ELMO SUBDIVISION 1 & 2 & 3
- HYPOCHLORINATION, POST

MO6069069
ELSBERRY HEALTH CARE CENTER
- ION EXCHANGE

MO6010250
ELSBERRY PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5010999
EMERALD BEACH VILLAGE OF PWS
- HYPOCHLORINATION, POST

MO4010253
EMINENCE PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO6069070
EMMAUS HOMES INC
- HYPOCHLORINATION, POST

MO5280562
EMPIRE DIST ELEC OZARK BEACH
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4010255
ESSEX PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, DIFFUSED
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- SEQUESTRATION

MO6010258
EUREKA PWS
- 4-LOG TREATMENT OF VIRUSES
- FLUORIDATION
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO3031336
EVERGREEN CONDOMINIUMS
- FILTRATION, RAPID SAND
- HYPOCHLORINATION, POST

MO6036134
EVERGREEN LAKE ESTATES
- HYPOCHLORINATION, POST

System Treatment Processes

MO1010261
EXCELSIOR SPRINGS PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- RAPID MIX
- SEDIMENTATION

MO5010262
EXETER PWS
- HYPOCHLORINATION, POST

MO4292673
EXPRESS FUEL
- ACTIVATED CARBON, GRANULAR
- HYPOCHLORINATION, POST

MO5069056
FAIR HAVEN CHILDRENS HOME
- HYPOCHLORINATION, POST

MO5010264
FAIR PLAY PWS
- HYPOCHLORINATION, POST

MO5010267
FAIRVIEW PWS
- HYPOCHLORINATION, POST

MO6036161
FAIRWAYS WATER AND SEWER ASSN
- HYPOCHLORINATION, POST

MO5031149
FALL CREEK HEIGHTS SUBD
- HYPOCHLORINATION, POST

MO4069041
FARMINGTON CORRECTIONAL CENTER
- HYPOCHLORINATION, POST
- ION EXCHANGE
- SEQUESTRATION

MO4069065
FARMINGTON MANOR
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4010270
FARMINGTON PWS
- FLUORIDATION
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4030223
FARRAR WATER ASSN
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO3218100
FATTIES RENDEZVOUS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3036175
FAWN VALLEY ESTATES
- HYPOCHLORINATION, POST

MO5272936
FELLOWSHIP BIBLE CHURCH
- ION EXCHANGE

MO6010276
FESTUS PWS
- GASEOUS CHLORINATION, POST

MO5190943
FIN AND FEATHER RESORT PROPERTY HOA
- HYPOCHLORINATION, POST

MO5036273
FINLEY VALLEY/CITY OF OZARK
- HYPOCHLORINATION, POST

MO5190944
FISH HOOK RESORT
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5190942
FISH N FUN RESORT
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5252511
FISHERMANS TABLE ROCK IMPRVMNT ASSN
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

System Treatment Processes

MO4010278
FISK PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO5191681
FLAT CREEK RESORT
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5010903
FLEMINGTON PWS
- HYPOCHLORINATION, POST

MO6182070
FLYING J TRAVEL PLAZA
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5036100
FOREST PARK/DEER PARK
- HYPOCHLORINATION, POST

MO3079500
FORT LEONARD WOOD
- COAGULATION
- FILTERED
- FILTRATION, CARTRIDGE
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- HYPOCHLORINATION, PRE
- ION EXCHANGE
- RAPID MIX
- SEDIMENTATION
- ULTRAVIOLET RADIATION

MO5048281
FOUNTAIN PLAZA MHP
- HYPOCHLORINATION, POST

MO5203145
FOX FITNESS 24
- HYPOCHLORINATION, POST

MO5036197
FOX WOODS SUBDIVISION
- HYPOCHLORINATION, POST

MO6036323
FOXBORO SUBDIVISION
- FILTRATION, CARTRIDGE

MO6024211
FRANKLIN COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO6031215
FRANKLIN COUNTY PWSD 1 CARDINAL MEADOWS
- HYPOCHLORINATION, POST

MO6024213
FRANKLIN COUNTY PWSD 3
- HYPOCHLORINATION, POST

MO6036075
FRANKLIN COUNTY PWSD 3 LAKE SERENE
- HYPOCHLORINATION, POST

MO6079516
FRANKLIN COUNTY PWSD 3 ST ALBANS
- HYPOCHLORINATION, POST
- PERMANGANATE

MO6171153
FRANKLIN COUNTY SPECIAL SCHOOL DIST
- ION EXCHANGE

MO5213087
FRATERNAL ORDER OF BEARS # 27
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5218153
FRATERNAL ORDER OF EAGLE 3948
- HYPOCHLORINATION, POST

MO5282882
FRATERNAL ORDER OF THE BEARS 99
- ION EXCHANGE

System Treatment Processes

MO4010290
FREDERICKTOWN PWS
- ACTIVATED CARBON, GRANULAR
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PERMANGANATE
- PH ADJUSTMENT
- RAPID MIX
- SEDIMENTATION

MO5010941
FREISTATT PWS
- HYPOCHLORINATION, POST

MO5031165
FRIENDSHIP HILLS SUBD
- HYPOCHLORINATION, POST

MO4010293
FROHNA PWS
- HYPOCHLORINATION, PRE

MO6036101
FRONTIER ESTATES
- HYPOCHLORINATION, PRE

MO5238302
FUGATE MOBILE HOME PARK
- HYPOCHLORINATION, POST

MO3010296
FULTON PWS
- 4-LOG TREATMENT OF VIRUSES
- GASEOUS CHLORINATION, POST

MO3258215
G 2 M SUPER MART
- HYPOCHLORINATION, POST

MO5010297
GAINESVILLE PWS
- HYPOCHLORINATION, POST

MO5171580
GALENA ABESVILLE ELEMENTARY SCHOOL
- HYPOCHLORINATION, POST

MO5010298
GALENA PWS
- HYPOCHLORINATION, POST

MO1010299
GALLATIN PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, RAPID SAND
- HYPOCHLORINATION, PRE
- SEDIMENTATION
- SEQUESTRATION

MO1010301
GARDEN CITY PWS
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO4211081
GARDENS INN
- ION EXCHANGE

MO3190064
GASCONADE HILLS
- HYPOCHLORINATION, PRE

MO6010302
GASCONADE PWS
- HYPOCHLORINATION, PRE

MO6293181
GASMART HYWAY 67 MOBIL
- ACTIVATED CARBON, GRANULAR
- ION EXCHANGE
- OZONATION, PRE
- PEROXIDE
- ULTRAVIOLET RADIATION

System Treatment Processes

MO5292590
GATEWAY TO BRANSON EXPRESS STOP
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO5212635
GEARHEAD GRILL
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO3180628
GENERAL CABLE
- HYPOCHLORINATION, POST

MO5181388
GEORGES PROCESSING INC
- HYPOCHLORINATION, POST

MO5292861
GET N SPLIT
- HYPOCHLORINATION, POST

MO4010304
GIDEON PWS
- GASEOUS CHLORINATION, POST

MO3031323
GINGER COVE SUBDIVISION
- ION EXCHANGE

MO1010307
GLADSTONE PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- RAPID MIX
- SEDIMENTATION

MO2010308
GLASGOW PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5252173
GLEN OAKS SUBD
- HYPOCHLORINATION, POST

MO5048286
GOBBLERS KNOB MOBILE HOME PARK
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5036170
GOBBLERS MOUNTAIN/PARKVIEW WATER ASSOCIA
- HYPOCHLORINATION, POST

MO5191965
GOLDEN ARROW RESORT
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO5010313
GOLDEN CITY PWS
- HYPOCHLORINATION, POST

MO5031325
GOLDEN OAK VILLAGE SUBD
- HYPOCHLORINATION, POST

MO5010315
GOODMAN PWS
- GASEOUS CHLORINATION, POST

MO5190914
GOODYS RESORT
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO6120155
GRAHAM CAVE STATE PARK CAMPGROUND
- HYPOCHLORINATION, PRE

MO6122671
GRAHAM CAVE STATE PARK OFFICE
- HYPOCHLORINATION, POST

System Treatment Processes

MO1010319
GRAHAM PWS
- HYPOCHLORINATION, POST

MO5031492
GRAND CRU LANDING AT THE LAKE SUB
- HYPOCHLORINATION, POST

MO3190267
GRAND RIVER RESORT
- AERATION, CASCADE
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4010322
GRANDIN PWS
- HYPOCHLORINATION, POST

MO6048248
GRANDVIEW PLAZA MHP
- HYPOCHLORINATION, POST

MO6171788
GRANDVIEW R 2 SCHOOL
- HYPOCHLORINATION, POST

MO3191285
GRAVOIS VILLAGE CONDOS
- ION EXCHANGE

MO4010701
GRAYHAWK WATER
- HYPOCHLORINATION, POST

MO4172842
GREAT CIRCLE DAYCARE
- HYPOCHLORINATION, PRE

MO5031621
GREEN ACRES HOMEOWNERS ASSOCIATION
- HYPOCHLORINATION, POST

MO3010332
GREEN RIDGE PWS
- HYPOCHLORINATION, POST

MO5036102
GREEN SHORES SUBD
- HYPOCHLORINATION, POST

MO5190993
GREEN VALLEY RESORT
- HYPOCHLORINATION, POST
- PH ADJUSTMENT

MO5024228
GREENE COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO5024230
GREENE COUNTY PWSD 5
- HYPOCHLORINATION, POST

MO5024231
GREENE COUNTY PWSD 6
- HYPOCHLORINATION, POST

MO5036094
GREENE HILLS COUNTRY CLUB
- FILTRATION, CARTRIDGE
- ULTRAVIOLET RADIATION

MO5031115
GREENE HILLS WATER ASSN
- HYPOCHLORINATION, POST

MO5010331
GREENFIELD PWS
- HYPOCHLORINATION, POST

MO6162373
GREENSFELDER COUNTY PARK
- HYPOCHLORINATION, POST

MO5248121
H ROE BARTLE SCOUT RESERVATION
- FAT PIPE
- GASEOUS CHLORINATION, POST

MO3212416
HALFWAY INN
- FILTRATION, CARTRIDGE

System Treatment Processes

MO1010342
HAMILTON PWS

- ACTIVATED CARBON, POWDERED
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5290233
HANNAHS GENERAL STORE

- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO2010344
HANNIBAL PWS

- ACTIVATED CARBON, POWDERED
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION
- ULTRAVIOLET RADIATION

MO5191013
HAPPY HOLLOW RESORT

- HYPOCHLORINATION, POST

MO5193100
HAPPY OS SPORTSMAN RESORT

- ION EXCHANGE

MO5112098
HARBOR CAMPGROUND AND MARINA

- HYPOCHLORINATION, POST

MO1024242
HARRISON COUNTY PWSD 2

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- CHLORAMINES
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, PRE
- INHIBITOR, POLYPHOSPHATE
- SEDIMENTATION

MO1010349
HARRISONVILLE PWS

- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, POST
- SEDIMENTATION

MO1024247
HARRY S TRUMAN PWSD 2

- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO1122649
HARRY S TRUMAN STATE PARK CAMPGRD

- HYPOCHLORINATION, PRE

MO1122648
HARRY S TRUMAN STATE PARK MARINA

- HYPOCHLORINATION, PRE

MO3041238
HATTON HILLS MHP

- HYPOCHLORINATION, POST

MO3241404
HAVA SPACE RV PARK

- ION EXCHANGE

MO3036354
HAWK ISLAND ESTATES

- FILTRATION, GREENSAND
- HYPOCHLORINATION, POST

System Treatment Processes

MO6010353
HAWK POINT PWS
- HYPOCHLORINATION, POST

MO3191837
HAWKS NEST CONDO ASSN
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4120067
HAWN STATE PARK
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT

MO4010959
HAYTI HEIGHTS PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, PACKED TOWER
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, POST
- PERMANGANATE

MO4010354
HAYTI PWS
- FILTRATION, GREENSAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE

MO4010971
HAYWOOD CITY PWS
- FILTRATION, GREENSAND
- HYPOCHLORINATION, POST
- PERMANGANATE
- PH ADJUSTMENT
- SEDIMENTATION

MO5048177
HEIM MHP
- HYPOCHLORINATION, PRE

MO1010177
HENRY COUNTY WATER COMPANY
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- HYPOCHLORINATION, POST
- LIME - SODA ASH ADDITION
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO4048241
HENRYS MOBILE HOME PARK
- HYPOCHLORINATION, PRE

MO6010359
HERCULANEUM PWS
- GASEOUS CHLORINATION, POST

MO6010360
HERMANN PWS
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, POST

MO5010361
HERMITAGE PWS
- HYPOCHLORINATION, POST

MO5171257
HICKORY COUNTY R I SCHOOLS
- HYPOCHLORINATION, POST

MO5210920
HICKORY RIDGE HWY 83 MARINA & RESORT
- HYPOCHLORINATION, PRE

MO3190264
HIDDEN LAKE MOTEL
- ION EXCHANGE

MO3031207
HIDDEN OAKS ESTATES
- ION EXCHANGE

MO5031153
HIDDEN SHORES SUBD
- HYPOCHLORINATION, POST

MO4202639
HIDDEN VALLEY FISHING CLUB
- HYPOCHLORINATION, POST

System Treatment Processes

MO5243102
HIDDEN VALLEY OUTFITTERS
- ION EXCHANGE

MO5190971
HIDE AWAY RESORT
- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO1010363
HIGGINSVILLE PWS
- ACTIVATED CARBON, POWDERED
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO3171198
HIGH POINT ELEMENTARY SCHOOL
- HYPOCHLORINATION, PRE
- ION EXCHANGE
- SEQUESTRATION

MO5030690
HIGHLANDS SEWER & WATER ASSN INC
- HYPOCHLORINATION, POST

MO5024134
HIGHLANDVILLE PWS
- HYPOCHLORINATION, POST

MO3212583
HILLBILLY YACHT CLUB
- HYPOCHLORINATION, POST

MO4036038
HILLCREST UTILITY OPERATING COMPANY INC
- HYPOCHLORINATION, POST

MO3210326
HILLTOP BAR B Q
- HYPOCHLORINATION, PRE

MO5036236
HILLTOP WATER CORP
- HYPOCHLORINATION, POST

MO4182616
HOLCIM US INC LEE ISLAND PROJECT
- HYPOCHLORINATION, POST

MO4010370
HOLCOMB PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO1010371
HOLDEN PWS
- ACTIVATED CARBON, GRANULAR
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5190986
HOLIDAY HIDEAWAY RESORT
- FAT PIPE
- HYPOCHLORINATION, POST

MO5036188
HOLIDAY HILLS OF STONE COUNTY
- HYPOCHLORINATION, POST

MO5190947
HOLIDAY HILLS RESORT
- GASEOUS CHLORINATION, PRE

MO6190564
HOLIDAY INN AT SIX FLAGS
- FLOCCULATION
- OZONATION, PRE

MO5253105
HOLIDAY VALLEY SUBDIVISION
- HYPOCHLORINATION, POST

System Treatment Processes

MO5010374
HOLLISTER PWS
- HYPOCHLORINATION, POST

MO5272977
HOLY FAMILY CATHOLIC CHURCH
- HYPOCHLORINATION, POST

MO5212053
HOODS SERVICE CENTER INC
- HYPOCHLORINATION, POST
- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO1010378
HOPKINS PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, PRE
- PH ADJUSTMENT
- PH ADJUSTMENT, PRE
- SEDIMENTATION

MO5048047
HORIZON MHP
- HYPOCHLORINATION, POST

MO5031284
HORIZON WEST SUBDIVISION
- HYPOCHLORINATION, POST

MO4010382
HOUSTON PWS
- FLUORIDATION

MO3010384
HOUSTONIA PWS
- HYPOCHLORINATION, POST

MO2021598
HOWARD COUNTY REGIONAL WATER COMM
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- SEDIMENTATION

MO4024264
HOWELL COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO5010387
HUMANSVILLE PWS
- GASEOUS CHLORINATION, PRE

MO5190974
HUNTERS FRIEND RESORT INC
- ACTIVATED CARBON, GRANULAR
- ION EXCHANGE

MO6031362
HUNTERS GLEN
- GASEOUS CHLORINATION, POST

MO4031206
HUNTERS RIDGE SUBD
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5273030
HURLEY CHURCH OF GOD
- FILTRATION, CARTRIDGE
- ULTRAVIOLET RADIATION

MO3218012
HURRICANE DOLLYS
- 4-LOG TREATMENT OF VIRUSES
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO5048974
HWY 43 MOBILE HOME & RV PARK
- HYPOCHLORINATION, POST

MO5211719
HWY 59 CAFE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4203026
HWY 60 RV PARK/MORGAN RENTALS LLC
- ION EXCHANGE

System Treatment Processes

MO3010396
IBERIA PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- HYPOCHLORINATION, POST

MO1010399
INDEPENDENCE PWS
- 4-LOG TREATMENT OF VIRUSES
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- SEDIMENTATION

MO5036272
INDIAN HILLS HOMEOWNERS ASSN
- HYPOCHLORINATION, POST

MO5191931
INDIAN HILLS RESORT
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6036052
INDIAN HILLS UTILITIES OPERATING COMPANY
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO5250539
INDIAN POINT CONDOMINIUM
- HYPOCHLORINATION, POST

MO5190968
INDIAN TRAILS RESORT
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6036142
INNSBROOK
- HYPOCHLORINATION, POST
- SEQUESTRATION

MO5041190
IRIS ROAD LLC
- HYPOCHLORINATION, POST

MO6010401
IRONDALE PWS
- HYPOCHLORINATION, POST

MO4010402
IRONTON PWS
- ACTIVATED CARBON, GRANULAR
- COAGULATION
- FILTRATION, GREENSAND
- FLOCCULATION
- HYPOCHLORINATION, POST
- MICROSCREENING
- PH ADJUSTMENT, POST
- RAPID MIX
- SEDIMENTATION

MO3190821
IVY BEND RESORT
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5256172
JACKSON HOLLOW ADDITION
- HYPOCHLORINATION, POST

MO4010404
JACKSON PWS
- 4-LOG TREATMENT OF VIRUSES
- COAGULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO5036115
JAMES RIVER ADDITION
- HYPOCHLORINATION, POST

MO5031315
JAMES RIVER ESTATES SUBD
- HYPOCHLORINATION, POST

MO3010407
JAMESTOWN PWS
- HYPOCHLORINATION, POST

MO5024286
JASPER COUNTY PWSD 1
- GASEOUS CHLORINATION, POST

System Treatment Processes

MO5024287
JASPER COUNTY PWSD 2
- GASEOUS CHLORINATION, POST
- SEQUESTRATION

MO5010408
JASPER PWS
- HYPOCHLORINATION, POST

MO6140960
JAY HENGES RANGE
- HYPOCHLORINATION, POST

MO6079508
JEFF COUNTY REHAB PARTNERS LP
- ION EXCHANGE

MO6203084
JEFFERSON COUNTPARKS DEPT SPORTS COMPLEX
- FILTRATION, CARTRIDGE

MO6024296
JEFFERSON COUNTY PWSD 5
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, POST
- SEQUESTRATION

MO6024298
JEFFERSON COUNTY PWSD 6
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE

MO6024299
JEFFERSON COUNTY PWSD 7
- FLUORIDATION
- GASEOUS CHLORINATION, POST

MO6024300
JEFFERSON COUNTY PWSD 8
- FAT PIPE
- FLUORIDATION
- GASEOUS CHLORINATION, PRE

MO6024304
JEFFERSON COUNTY PWSD 12
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- HYPOCHLORINATION, POST

MO6024293
JEFFERSON COUNTY PWSD 2
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, POST
- SEDIMENTATION
- SEQUESTRATION
- ULTRAVIOLET RADIATION

MO6071352
JEFFERSON COUNTY WATER AUTHORITY
- AERATION, PACKED TOWER
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- INHIBITOR, BIMETALLIC PHOSPHAT
- LIME - SODA ASH ADDITION
- RED. AGENT, SODIUM BISULFITE
- REDUCING AGENT, SODIUM SULFITE
- SEDIMENTATION

MO1212836
JESTERS HOUSE
- ION EXCHANGE

MO5293125
JOE BALD MARKET
- FILTRATION, CARTRIDGE
- ULTRAVIOLET RADIATION

MO5188304
JOHN TWITTY ENERGY CENTER
- HYPOCHLORINATION, PRE

MO4036309
JOHNS BRANCH WATER CO
- HYPOCHLORINATION, PRE

System Treatment Processes

MO1024310
JOHNSON COUNTY PWSD 2
- GASEOUS CHLORINATION, PRE

MO1024311
JOHNSON COUNTY PWSD 3
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, POST
- SEQUESTRATION

MO4120158
JOHNSON SHUTINS STATE PARK
- HYPOCHLORINATION, POST

MO5212921
JOLLY ROGERS
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6010412
JONESBURG PWS
- HYPOCHLORINATION, POST

MO5242867
JOPLIN SHOAL CREEK RV
- HYPOCHLORINATION, POST

MO5071459
JOYCE RENTALS
- HYPOCHLORINATION, POST

MO6212332
JR DIAMONDS
- ION EXCHANGE

MO5211664
JUNCTION STORE LLC
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO5292515
KAD E KORNER
- FAT PIPE
- HYPOCHLORINATION, POST

MO2010414
KAHOKA PUBLIC WORKS
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION
- SEQUESTRATION

MO5242626
KANAKUK K KAUAI
- HYPOCHLORINATION, POST

MO5248293
KANAKUK KAMP NO 1
- HYPOCHLORINATION, POST

MO5248295
KANAKUK KAMP NO 2
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5240662
KANAKUK KAMP NO 7
- HYPOCHLORINATION, POST

MO1010415
KANSAS CITY PWS
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PERMANGANATE
- RAPID MIX
- SEDIMENTATION
- SEQUESTRATION

MO3191903
KAY LYNN RESORT
- HYPOCHLORINATION, PRE

MO5252903
KE JO #IV HOA
- HYPOCHLORINATION, POST

MO5252904
KE JO POINT HOA
- HYPOCHLORINATION, PRE

System Treatment Processes

MO1010416
KEARNEY PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT
- SEDIMENTATION

MO3036166
KEITHLEY BEACH SUBD

- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO5233202
KELLYS PORT MARINA

- ION EXCHANGE

MO4010924
KELSO PWS

- HYPOCHLORINATION, POST

MO4010417
KENNETT PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- RAPID MIX
- SEDIMENTATION

MO3071239
KEYSTONE VILLAGE CONDOS

- FILTRATION, PRESSURE SAND

MO2010420
KEYTESVILLE PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5248294
KIDS ACROSS AMERICA

- HYPOCHLORINATION, POST

MO4170531
KIDZ WORLD DAYCARE & PRESCHOOL

- HYPOCHLORINATION, PRE

MO4036256
KILLARNEY SHORES SUBD

- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO5036356
KIMBERLING AIRWAYS SUBD

- HYPOCHLORINATION, POST

MO5282512
KIMBERLING AREA SENIOR CENTER

- ION EXCHANGE

MO5036082
KIMBERLING CITY OF GOLDEN ACRES PWS

- HYPOCHLORINATION, POST

MO5211572
KIMBERLING INN AT TABLE ROCK RESORT

- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

System Treatment Processes

MO1010425
KING CITY PWS
CHLORINE DIOXIDE
COAGULATION
FILTRATION, RAPID SAND
FLOCCULATION
GASEOUS CHLORINATION, POST
GASEOUS CHLORINATION, PRE
RAPID MIX
SEDIMENTATION
SLUDGE TREATMENT

MO3010424
KINGDOM CITY PWS
HYPOCHLORINATION, POST

MO5031309
KINGS RIVER BEACH WATER ASSOCIATION INC
HYPOCHLORINATION, POST

MO1010426
KINGSTON PWS
4-LOG TREATMENT OF VIRUSES
AERATION, SLAT TRAY
FILTRATION, PRESSURE SAND
HYPOCHLORINATION, PRE
PERMANGANATE
PH ADJUSTMENT, PRE
SEDIMENTATION

MO2010429
KIRKSVILLE PWS
ACTIVATED CARBON, POWDERED
ALGAE CONTROL
CHLORAMINES
CHLORINE DIOXIDE
COAGULATION
FILTRATION, RAPID SAND
FLOCCULATION
FLUORIDATION
GASEOUS CHLORINATION, POST
GASEOUS CHLORINATION, PRE
PERMANGANATE
PH ADJUSTMENT, PRE
RAPID MIX
SEDIMENTATION

MO1262871
KIRN LAKEVIEW RV PARK
HYPOCHLORINATION, POST

MO5036182
KNOB HILL ACRES
HYPOCHLORINATION, POST

MO1010432
KNOB NOSTER PWS
HYPOCHLORINATION, POST
HYPOCHLORINATION, PRE

MO1122656
KNOB NOSTER STATE PARK SHAWNEE
HYPOCHLORINATION, PRE

MO5241734
KOA CAMPGROUND
HYPOCHLORINATION, POST

MO4010434
KOSHKONONG PWS
HYPOCHLORINATION, POST
HYPOCHLORINATION, PRE

MO5180648
KRAFT HEINZ FOOD COMPANY
GASEOUS CHLORINATION, POST

MO3036153
KUHLE H20
HYPOCHLORINATION, POST

MO5292802
KUM & GO 29
FILTRATION, CARTRIDGE
REVERSE OSMOSIS
ULTRAVIOLET RADIATION

MO5290086
KUM & GO 498
FILTRATION, CARTRIDGE
ION EXCHANGE
ULTRAVIOLET RADIATION

MO3010448
LA MONTE PWS
HYPOCHLORINATION, POST

System Treatment Processes

MO5024317
LACLEDE COUNTY PWSD 1
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, POST

MO5024318
LACLEDE COUNTY PWSD 2
- HYPOCHLORINATION, POST

MO2010437
LACLEDE PWS
- HYPOCHLORINATION, POST

MO2010438
LADDONIA PWS
- 4-LOG TREATMENT OF VIRUSES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO1024326
LAF/JO/SALINE COUNTY CONS PWSD 2
- HYPOCHLORINATION, POST

MO2010440
LAGRANGE PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, GREENSAND
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- SEDIMENTATION

MO6036077
LAKE ADELLE SUBD
- HYPOCHLORINATION, POST

MO3190784
LAKE BREEZE RESORT
- ION EXCHANGE

MO1079505
LAKE CITY ARMY AMMUNITION PLT
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT
- SEDIMENTATION

MO5030178
LAKE COUNTRY VILLAGE POA
- HYPOCHLORINATION, POST

MO6213210
LAKE CREEK FARM WINERY
- ION EXCHANGE

MO5036203
LAKE FOREST SUBDIVISION
- HYPOCHLORINATION, POST

MO3210904
LAKE HILLS MOTEL
- HYPOCHLORINATION, PRE

MO5048754
LAKE MEADOWS MHP
- HYPOCHLORINATION, POST

MO5122662
LAKE OZARK STATE PARK ADMINISTRATION
- FAT PIPE
- HYPOCHLORINATION, POST

MO5122664
LAKE OZARK STATE PARK CLOVER POINT
- HYPOCHLORINATION, POST

MO5122661
LAKE OZARK STATE PARK HOMESTEAD
- HYPOCHLORINATION, POST

MO5122670
LAKE OZARK STATE PARK OUTPOST
- HYPOCHLORINATION, POST

System Treatment Processes

MO5122666
LAKE OZARK STATE PARK PIN OAK
- HYPOCHLORINATION, POST

MO5122667
LAKE OZARK STATE PARK RED BUD
- HYPOCHLORINATION, POST

MO5122663
LAKE OZARK STATE PARK RISING SUN
- HYPOCHLORINATION, POST

MO5031625
LAKE POINT LANDING POA INC
- HYPOCHLORINATION, POST

MO3280530
LAKE REGIONAL HEALTH SYSTEM
- GASEOUS CHLORINATION, POST
- ION EXCHANGE

MO4256181
LAKE SEVEN FALLS ASSN INC
- HYPOCHLORINATION, POST

MO6036039
LAKE SHERWOOD SUBD
- HYPOCHLORINATION, POST

MO5191757
LAKE SHORE RESORT LLC
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO5036012
LAKE TANEYCOMO WOODS
- HYPOCHLORINATION, POST

MO3208008
LAKE VALLEY COUNTRY CLUB
- ION EXCHANGE

MO4120161
LAKE WAPPAPELLO STATE PARK
- HYPOCHLORINATION, POST

MO1010880
LAKE WINNEBAGO PWS
- FLUORIDATION

MO3182336
LAKE WOOD CENTER
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5069068
LAKESIDE MOUNTAIN MANOR
- HYPOCHLORINATION, POST

MO3191521
LAKEVIEW BEACH RESORT
- HYPOCHLORINATION, POST
- ULTRAVIOLET RADIATION

MO5240839
LAKEVIEW CAMPGROUND LLC
- HYPOCHLORINATION, PRE

MO5036268
LAKEVIEW SUBD BLOCK C
- HYPOCHLORINATION, POST

MO5010446
LAMAR PWS
- ACTIVATED CARBON, POWDERED
- CHLORINE DIOXIDE
- COAGULATION
- FILTERED
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- RAPID MIX
- SEDIMENTATION

MO5010449
LANAGAN PWS
- HYPOCHLORINATION, POST

MO5071085
LANTERN BAY RESORT CONDO
- HYPOCHLORINATION, POST

MO3212536
LARRYS ON THE LAKE
- ION EXCHANGE

MO6048147
LAUREL ACRES MHP
- HYPOCHLORINATION, POST

System Treatment Processes

MO3024413
LAURIE PWS
- GASEOUS CHLORINATION, POST

MO3190706
LAZY DAYS CONDOMINIUMS
- ION EXCHANGE

MO5190949
LAZY LEES RESORT
- HYPOCHLORINATION, POST

MO5191029
LAZY VALLEY RESORT
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO4010456
LEADWOOD PWS
- 4-LOG TREATMENT OF VIRUSES
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- REDUCING AGENT, SULFUR DIOXIDE

MO5010458
LEBANON PWS
- 4-LOG TREATMENT OF VIRUSES
- FLUORIDATION
- GASEOUS CHLORINATION, POST

MO1010460
LEETON PWS
- GASEOUS CHLORINATION, POST

MO5211235
LEGENDS RESTAURANT AND BAR
- HYPOCHLORINATION, POST

MO5180608
LEGGETT & PLATT
- HYPOCHLORINATION, POST

MO3212558
LEHMANS RESTAURANT
- ION EXCHANGE

MO5256026
LEISURE SHORES UNIT 1
- HYPOCHLORINATION, POST

MO5036145
LEISURE SHORES UNIT 2
- HYPOCHLORINATION, POST

MO4218522
LENNYS
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO1010464
LEXINGTON PWS
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- SEDIMENTATION
- ULTRAVIOLET RADIATION

MO5010465
LIBERAL PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, PACKED TOWER
- GASEOUS CHLORINATION, POST

MO1010466
LIBERTY PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, PACKED TOWER
- CHLORAMINES
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- LIME - SODA ASH ADDITION
- SEDIMENTATION
- SLUDGE TREATMENT

MO4171258
LIBERTY SENIOR HIGH SCHOOL
- ION EXCHANGE

System Treatment Processes

MO5010577
LIBERTY WATER NOEL
- GASEOUS CHLORINATION, POST

MO5191573
LIGHTHOUSE LODGE RESORT
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4282521
LIGHTNING BOWL
- ULTRAVIOLET RADIATION

MO4010468
LILBOURN PWS
- FILTRATION, GREENSAND
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- SEDIMENTATION

MO5191989
LILLEYS LANDING RESORT
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6024340
LINCOLN COUNTY PWSD 1
- GASEOUS CHLORINATION, POST

MO5031456
LINDLEY COVE WELL ASSOCIATION
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO2024346
LINN COUNTY CONS PWSD 1
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- SEDIMENTATION

MO3010471
LINN CREEK PWS
- FAT PIPE
- HYPOCHLORINATION, POST

MO2024350
LINN LIVINGSTON COUNTY PWSD 3
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO3010470
LINN PWS
- GASEOUS CHLORINATION, POST

MO5218149
LITTLE GUYS BASEBALL CLUB
- HYPOCHLORINATION, POST

MO6241571
LIVING WELL VILLAGE
- HYPOCHLORINATION, PRE

MO2024353
LIVINGSTON COUNTY PWSD 2
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, SLOW SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

System Treatment Processes

MO2024355
LIVINGSTON COUNTY PWSD 4
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5010475
LOCKWOOD PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- GASEOUS CHLORINATION, POST

MO5171169
LOGAN ROGERSVILLE ELEMENTARY SCHOOL
- HYPOCHLORINATION, POST

MO5172701
LOGAN ROGERSVILLE HIGH SCHOOL
- HYPOCHLORINATION, POST

MO5171256
LOGAN ROGERSVILLE MIDDLE SCHOOL
- HYPOCHLORINATION, POST

MO5031174
LOGGERS ASSN
- HYPOCHLORINATION, POST

MO6202395
LONE ELK COUNTY PARK
- ION EXCHANGE

MO3190708
LONE OAK POINT CONDOMINIUMS
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6171159
LONEDELL R XIV ELEMENTARY SCHOOL
- ION EXCHANGE

MO5251612
LONG ACRES SUBDIVISION
- HYPOCHLORINATION, POST

MO5031233
LONG BEND SUBD
- ULTRAVIOLET RADIATION

MO5036016
LONGVIEW SUBDIVISION
- HYPOCHLORINATION, POST

MO4036306
LOST CREEK WATER COMPANY
- HYPOCHLORINATION, PRE

MO5202448
LOST WOODS GOLF COURSE
- HYPOCHLORINATION, POST

MO5011068
LOUISBURG PWS
- HYPOCHLORINATION, POST
- SEQUESTRATION

MO2010479
LOUISIANA PWS
- 1-LOG TREATMENT OF CRYPTO
- 3-LOG REMOVE/INACTIV G LAMBLIA
- ACTIVATED CARBON, GRANULAR
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION
- ULTRAVIOLET RADIATION

MO6282894
LOUTRE MARKET
- ION EXCHANGE

MO3281053
LOUTRE SHORE COUNTRY CLUB
- ION EXCHANGE

System Treatment Processes

MO5292463
LOVES TRAVEL STOP 282
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4242910
LUCKY CLOVER RIVER RESORT INC
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO5048294
LUCKY LADY MOBILE HOME PARK
- HYPOCHLORINATION, POST

MO1041228
M & M MOBILE HOME PARK
- HYPOCHLORINATION, POST

MO6048148
MACKENZIE RIDGE LLC
- ION EXCHANGE

MO2010487
MACON PWS
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- PH ADJUSTMENT, POST
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO4024368
MADISON COUNTY PWSD 1 NORTH AND SOUTH
- GASEOUS CHLORINATION, PRE

MO1010489
MAITLAND PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT
- SEDIMENTATION

MO6031412
MAJESTIC LAKES
- HYPOCHLORINATION, POST

MO3031208
MAKALU ESTATES
- HYPOCHLORINATION, POST

MO4010490
MALDEN PWS
- HYPOCHLORINATION, POST

MO5171242
MANES R V ELEMENTARY SCHOOL
- FILTERED

MO5010493
MANSFIELD PWS
- 4-LOG TREATMENT OF VIRUSES
- GASEOUS CHLORINATION, POST
- ION EXCHANGE

MO6170130
MAPLE GROVE ELEMENTARY SCHOOL
- ACTIVATED CARBON, GRANULAR

MO5211927
MAPLE HILL RESTAURANT
- HYPOCHLORINATION, POST

MO6048138
MAPLE RIDGE MHP
- HYPOCHLORINATION, POST

MO4010496
MARBLE HILL NORTH PWS
- GASEOUS CHLORINATION, POST

System Treatment Processes

MO4010483
MARBLE HILL SOUTH PWS

- GASEOUS CHLORINATION, POST

MO2010497
MARCELINE PWS

- ACTIVATED CARBON, POWDERED
- AERATION, SLAT TRAY
- ALGAE CONTROL
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO6281482
MARIANIST RETREAT CENTER

- HYPOCHLORINATION, POST

MO5191971
MARINA INN

- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5010499
MARIONVILLE

- HYPOCHLORINATION, POST

MO4010501
MARQUAND PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- SEDIMENTATION

MO2010502
MARSHALL PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SPRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5010503
MARSHFIELD PWS

- HYPOCHLORINATION, POST

MO4010504
MARSTON PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- SEDIMENTATION

MO2010506
MARTINSBURG PWS

- GASEOUS CHLORINATION, POST
- SEQUESTRATION

MO5210192
MARY DEANS RESTAURANT

- HYPOCHLORINATION, POST

MO1010508
MARYVILLE PWS

- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, ULTRAFILTRATION
- FLOCCULATION
- FLUORIDATION
- PERMANGANATE
- PH ADJUSTMENT, POST
- RAPID MIX
- SEDIMENTATION
- SLUDGE TREATMENT

System Treatment Processes

MO5292369
MASSIES SUPER STOP
- ULTRAVIOLET RADIATION

MO4010509
MATTHEWS PWS
- FILTRATION, PRESSURE SAND
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT

MO4212840
MATTS STEAKHOUSE
- ION EXCHANGE

MO5252337
MAYO BEACH SUBD
- HYPOCHLORINATION, POST

MO1010510
MAYSVILLE PWS
- 4-LOG TREATMENT OF VIRUSES
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO1010511
MAYVIEW PWS
- HYPOCHLORINATION, POST

MO5212329
MC CARTY SENIOR CENTER
- ION EXCHANGE

MO5024359
MC DONALD COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO5021113
MC DONALD COUNTY PWSD 2
- HYPOCHLORINATION, POST

MO5021168
MC DONALD COUNTY PWSD 3
- FAT PIPE
- GASEOUS CHLORINATION, POST

MO6036081
MEADOW DRIVE SUBD
- HYPOCHLORINATION, POST

MO5031142
MEADOW HILLS SUBDIVISION
- HYPOCHLORINATION, POST

MO5030915
MEADOW RIDGE SUBDIVISION
- HYPOCHLORINATION, POST

MO5031126
MEADOWOOD ESTATES SUBD
- HYPOCHLORINATION, POST

MO2010512
MEADVILLE PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO5031145
MELODY MANOR SUBDIVISION
- HYPOCHLORINATION, POST

MO2010513
MEMPHIS PWS
- ACTIVATED CARBON, POWDERED
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO6201448
MERAMEC CAVERNS
- HYPOCHLORINATION, POST

System Treatment Processes

MO6190241
MERAMEC CAVERNS MOTEL
- ION EXCHANGE

MO6122652
MERAMEC STATE PARK CAMPGRD
- HYPOCHLORINATION, POST

MO6122651
MERAMEC STATE PARK DINING LODGE
- HYPOCHLORINATION, POST

MO6122653
MERAMEC STATE PARK HICKORY RIDGE
- HYPOCHLORINATION, POST

MO6120162
MERAMEC STATE PARK VISITOR CENTER
- HYPOCHLORINATION, POST

MO6210144
MERAMEC VALLEY CAMP RESORT
- HYPOCHLORINATION, POST

MO5041253
MERITTS CAMPGROUND
- ULTRAVIOLET RADIATION

MO5036152
MERRIAM WOODS VILLAGE OF PWS
- GASEOUS CHLORINATION, POST

MO3198088
MICKEYLAND RESORT
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO4079503
MID AMERICA TEEN CHALLENGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO1070639
MIDDLE FORK WATER CO
- CHLORAMINES
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO6010521
MIDDLETOWN PWS
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5040176
MIDLAND WATER CO
- HYPOCHLORINATION, POST

MO5071108
MILANO HOUSE
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5190952
MILL CREEK RESORT
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5031254
MILL CREEK SHORES SUBD
- HYPOCHLORINATION, POST

MO4010527
MILL SPRING PWS
- HYPOCHLORINATION, PRE

MO5162714
MILLER COUNTY HEALTH CENTER
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO3162350
MILLER COUNTY JAIL
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5010525
MILLER PWS
- HYPOCHLORINATION, POST

System Treatment Processes

MO3232609
MILLERS LANDING
- FILTRATION, CARTRIDGE

MO4191461
MILLERS MOTOR LODGE
- HYPOCHLORINATION, POST

MO5292636
MILLERS ONE STOP
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3241441
MILLION SHOREWOOD LANDING
- HYPOCHLORINATION, POST

MO5031278
MILLWOOD ESTATES PROP OWNERS ASSN
- HYPOCHLORINATION, POST

MO5301396
MIMOSA BEACH CONDOMINIUMS
- ION EXCHANGE

MO5010530
MINDENMINES PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- GASEOUS CHLORINATION, POST

MO4010531
MINER PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, GREENSAND
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, POST
- PH ADJUSTMENT, PRE

MO4011123
MINERAL POINT PWS
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4102254
MINGO NATIONAL WILDLIFE REFUGE
- ION EXCHANGE

MO5241139
MINTAHAMA PROGRAM CENTER
- HYPOCHLORINATION, POST

MO5301501
MIRAMAR CONDOMINIUMS
- HYPOCHLORINATION, POST

MO6031523
MIRASOL SUBDIVISION
- HYPOCHLORINATION, POST

MO5069029
MISSOURI REHABILITATION CENTER
- 4-LOG TREATMENT OF VIRUSES
- GASEOUS CHLORINATION, POST

MO3152178
MISSOURI STATE CAPITOL
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5243013
MISSOURI TRAPSHOOTERS ASSOCIATION
- 4-LOG TREATMENT OF VIRUSES
- FAT PIPE
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO5210653
MITCHELLS PLAZA
- HYPOCHLORINATION, POST

MO6031475
MO AMERICAN ANNA MEADOWS
- HYPOCHLORINATION, POST

System Treatment Processes

MO2010109
MO AMERICAN BRUNSWICK

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, PRESSURE SAND
- FLOCCULATION
- GASEOUS CHLORINATION, PRE
- INHIBITOR, POLYPHOSPHATE
- PH ADJUSTMENT, PRE
- SEDIMENTATION
- SEQUESTRATION

MO5031148
MO AMERICAN EMERALD POINTE SUBD

- HYPOCHLORINATION, POST

MO3036043
MO AMERICAN HICKORY HILLS

- HYPOCHLORINATION, POST

MO6031461
MO AMERICAN JAXSON

- HYPOCHLORINATION, POST

MO3010409
MO AMERICAN JEFFERSON CITY DISTRICT

- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION
- SEQUESTRATION

MO3010146
MO AMERICAN JEFFERSON CITY NORTH

- HYPOCHLORINATION, POST

MO5010413
MO AMERICAN JOPLIN

- 1-LOG TREATMENT OF CRYPTO
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- HYPOCHLORINATION, POST
- LIME - SODA ASH ADDITION
- SEDIMENTATION
- ULTRAVIOLET RADIATION

MO3031183
MO AMERICAN LAKE CARMEL

- HYPOCHLORINATION, POST

MO5036198
MO AMERICAN LAKE TANEYCOMO ACRES SUBD

- HYPOCHLORINATION, POST

MO5036020
MO AMERICAN LAKEWOOD MANOR SUBD

- HYPOCHLORINATION, POST

MO3036131
MO AMERICAN MAPLEWOOD SUBDIVISION

- HYPOCHLORINATION, POST

System Treatment Processes

MO2010519
MO AMERICAN MEXICO

- 4-LOG TREATMENT OF VIRUSES
- AERATION, PACKED TOWER
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5036177
MO AMERICAN OZARK MTN WATER COMPANY 1

- HYPOCHLORINATION, POST

MO5036162
MO AMERICAN OZARK MTN WATER COMPANY 3

- HYPOCHLORINATION, POST

MO5036163
MO AMERICAN OZARK MTN WATER COMPANY 2

- HYPOCHLORINATION, POST

MO1010625
MO AMERICAN PLATTE COUNTY

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- INHIBITOR, POLYPHOSPHATE
- LIME - SODA ASH ADDITION

MO5036147
MO AMERICAN RANKIN ACRES SUBD

- HYPOCHLORINATION, POST

MO3031301
MO AMERICAN RED FIELD SUBDIVISION

- HYPOCHLORINATION, POST

MO5036210
MO AMERICAN RIVERSIDE ESTATES

- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5031375
MO AMERICAN SADDLEBROOKE VILLAGE OF

- GASEOUS CHLORINATION, POST

MO1010714
MO AMERICAN ST JOSEPH

- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- INHIBITOR, POLYPHOSPHATE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT
- RAPID MIX
- SEDIMENTATION

MO6010716
MO AMERICAN ST LOUIS ST CHARLES COUNTIES

- CHLORAMINES
- FILTERED
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- ION EXCHANGE
- LIME - SODA ASH ADDITION
- RAPID MIX
- SEDIMENTATION
- SLUDGE TREATMENT

System Treatment Processes

MO5031086
MO AMERICAN STONEBRIDGE VILLAGE
- GASEOUS CHLORINATION, POST

MO5024601
MO AMERICAN TRI STATE
- GASEOUS CHLORINATION, POST

MO3010831
MO AMERICAN WARDSVILLE
- HYPOCHLORINATION, POST

MO6036149
MO AMERICAN WARREN COUNT WATER & SEWER
- HYPOCHLORINATION, POST

MO1010833
MO AMERICAN WARRENSBURG
- 4-LOG TREATMENT OF VIRUSES
- GASEOUS CHLORINATION, PRE
- OZONATION, PRE

MO3036113
MO AMERICAN WHITEBRANCH SUBD
- HYPOCHLORINATION, POST

MO5036111
MO AMERICAN WOODLAND MANOR
- HYPOCHLORINATION, POST

MO5024591
MO ARK WATER CO
- HYPOCHLORINATION, POST

MO6069017
MO EASTERN CORRECTIONAL CENTER
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5248115
MO ST FREE WILL BAPTIST YOUTH CAMP
- HYPOCHLORINATION, POST

MO2010533
MOBERLY PWS
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT
- RAPID MIX
- SEDIMENTATION

MO5273008
MONARK BAPTIST CHURCH
- FILTRATION, CARTRIDGE
- ULTRAVIOLET RADIATION

MO5010537
MONETT PWS
- 4-LOG TREATMENT OF VIRUSES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- RAPID MIX
- SEDIMENTATION

MO3024396
MONITEAU COUNTY PWSD 2
- HYPOCHLORINATION, POST

MO2010538
MONROE CITY PWS
- ACTIVATED CARBON, POWDERED
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO4120163
MONTAUK STATE PARK
- HYPOCHLORINATION, PRE

System Treatment Processes

MO6283166
MONTELLE WINERY
- ION EXCHANGE

MO6010539
MONTGOMERY CITY PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- GASEOUS CHLORINATION, POST
- ION EXCHANGE

MO6024406
MONTGOMERY CO PWSD 1
- GASEOUS CHLORINATION, POST

MO3212429
MOONIES RESORT
- ION EXCHANGE

MO5036117
MOORE BEND WATER UTILITY LLC
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO4010543
MOREHOUSE PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, GREENSAND
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- PERMANGANATE
- SEDIMENTATION

MO3171200
MORGAN COUNTY R II SOUTH
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO4010945
MORLEY PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- SEDIMENTATION

MO5031511
MORNINGSIDE CHURCH RETREAT
- FAT PIPE
- HYPOCHLORINATION, POST

MO6010544
MORRISON PWS
- GASEOUS CHLORINATION, POST

MO6010547
MOSCOW MILLS PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE

MO1010548
MOUND CITY PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5172932
MOUNT VERNON MIGRANT HEAD START
- ULTRAVIOLET RADIATION

MO5010553
MOUNT VERNON PWS
- 4-LOG TREATMENT OF VIRUSES
- GASEOUS CHLORINATION, POST

MO5198039
MOUNTAIN COUNTRY MOTOR INN
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5036125
MOUNTAIN ESTATES
- HYPOCHLORINATION, POST

System Treatment Processes

MO5010550
MOUNTAIN GROVE PWS
- 4-LOG TREATMENT OF VIRUSES
- FAT PIPE
- HYPOCHLORINATION, POST

MO4010551
MOUNTAIN VIEW PWS
- HYPOCHLORINATION, PRE

MO5191320
MT CARMEL INN
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5230535
MUTTON CREEK MARINA
- FILTRATION, CARTRIDGE

MO6182491
NATIONAL CART COMPANY
- FILTRATION, GREENSAND
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO5283154
NATIONAL INSTITUTE OF MARRIAGE
- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO4010557
NAYLOR PWS
- GASEOUS CHLORINATION, POST

MO5031105
NEEDLES EYE BEACH
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO3212554
NEIGHBORS LANDING
- FILTRATION, CARTRIDGE

MO4171142
NELL HOLCOMB R 4 ELEMENTARY SCHOOL
- ION EXCHANGE

MO4282503
NELSONS MUSIC CITY
- HYPOCHLORINATION, POST

MO5010560
NEOSHO PWS
- ACTIVATED CARBON, POWDERED
- COAGULATION
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, PRE
- INHIBITOR, ORTHOPHOSPHATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO4180594
NESTLE PURINA PETCARE COMPANY
- ION EXCHANGE

MO5010562
NEVADA PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, PACKED TOWER
- GASEOUS CHLORINATION, POST
- INHIBITOR, BIMETALLIC PHOSPHAT
- PH ADJUSTMENT

MO3010563
NEW BLOOMFIELD PWS
- GASEOUS CHLORINATION, POST

MO5172883
NEW COVENANT CHURCH
- FILTRATION, CARTRIDGE

MO6180572
NEW FLORENCE WOOD PRODUCTS
- FILTRATION, CARTRIDGE
- ION EXCHANGE
- REVERSE OSMOSIS
- ULTRAVIOLET RADIATION

MO4172690
NEW HARMONY BAPTIST CHURCH
- ION EXCHANGE

MO5273016
NEW LIFE CHURCH OF THE NAZARENE
- ION EXCHANGE

MO5272723
NEW LIFE FELLOWSHIP CHURCH
- HYPOCHLORINATION, POST

System Treatment Processes

MO4024419
NEW MADRID COUNTY PWSD 5
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE

MO4010570
NEW MADRID PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, GREENSAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT

MO5272961
NEW SITE BAPTIST CHURCH
- FILTRATION, CARTRIDGE

MO3010887
NEWBURG PWS
- HYPOCHLORINATION, PRE
- SEQUESTRATION

MO5024423
NEWTON CO PWSD 1
- HYPOCHLORINATION, POST

MO5010575
NIANGUA PWS
- HYPOCHLORINATION, POST

MO6171157
NIKE ELEMENTARY SCHOOL
- ION EXCHANGE

MO5010576
NIXA PWS
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, POST

MO6213187
NOBOLEIS VINEYARDS
- ION EXCHANGE

MO2010578
NORBORNE PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- SEDIMENTATION

MO2021537
NORTH CENTRAL MO REGIONAL WATER COM
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO4036144
NORTH HILLS ESTATES
- HYPOCHLORINATION, PRE

MO1010580
NORTH KANSAS CITY PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT
- SEDIMENTATION

MO3238276
NORTH SHORE CONDOMINIUMS
- ION EXCHANGE

System Treatment Processes

MO6232941
NORTH SHORE MARINA
- ACTIVATED CARBON, GRANULAR
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6182514
NORTH TROY BUSINESS PARK
- ION EXCHANGE

MO5010585
NORWOOD PWS
- HYPOCHLORINATION, POST

MO3302306
OAK BLUFF CONDOMINIUMS
- ION EXCHANGE

MO5031194
OAK CREEK PARKWAY SUBD
- HYPOCHLORINATION, POST

MO5048194
OAK CREST ESTATES MOBILE HOME SUBD
- HYPOCHLORINATION, POST

MO5048178
OAK GROVE TRAILER PARK
- GASEOUS CHLORINATION, PRE

MO6010590
OAK GROVE VILLAGE PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, DIFFUSED
- HYPOCHLORINATION, POST

MO5048211
OAK HILL MHP
- HYPOCHLORINATION, POST

MO5190985
OAK HILL RESORT
- ION EXCHANGE

MO3250972
OAK POINT SUBDIVISION
- FILTRATION, CARTRIDGE
- ULTRAVIOLET RADIATION

MO5031544
OAK SHADOWS SUBDIVISION
- HYPOCHLORINATION, POST

MO5036250
OAK SHADOWS WATER ASSN
- HYPOCHLORINATION, POST

MO4036026
OAKBRIER ESTATES
- FAT PIPE
- HYPOCHLORINATION, PRE

MO5036300
OAKS HOMEOWNERS ASSN WATER DIST
- HYPOCHLORINATION, POST

MO5031526
OAKWOOD HOMEOWNERS ASSN
- HYPOCHLORINATION, POST

MO4293179
OASIS TRAVEL PLAZA LLC
- LIME - SODA ASH ADDITION

MO3031322
OCWC SPRING BRANCH WATER
- HYPOCHLORINATION, POST

MO1010599
ODESSA PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

System Treatment Processes

MO6010588
OFALLON PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, DIFFUSED
- CHLORAMINES
- COAGULATION
- FILTRATION, CARTRIDGE
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, PRE
- ION EXCHANGE
- PH ADJUSTMENT, POST
- PH ADJUSTMENT, PRE
- RED. AGENT, SODIUM BISULFITE
- REVERSE OSMOSIS
- SEDIMENTATION

MO5211851
OFFICE PUB & STEAKHOUSE
- HYPOCHLORINATION, POST

MO5212774
OH TOMMYS PUB & GRILL
- FILTRATION, CARTRIDGE

MO3031345
OKLATERRE MOBILE HOME PARK
- HYPOCHLORINATION, POST

MO6293060
OLD DUTCH MILL
- ION EXCHANGE

MO3031198
OLD KINDERHOOK COMMUNITY
- HYPOCHLORINATION, POST

MO5212967
OLD TOWN OSAGE
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6122199
ONONDAGA CAVE
- HYPOCHLORINATION, PRE

MO5251579
ONSTOTT/ORAHOOD SUBD
- HYPOCHLORINATION, POST

MO5063085
OPAL FOODS LLC
- HYPOCHLORINATION, POST

MO6172340
OPERATING ENGINEERS TRAINING SCHOOL
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4010604
ORAN PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO6171218
ORCHARD FARM SCHOOLS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- ION EXCHANGE
- PERMANGANATE

MO4024432
OREGON COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO4024433
OREGON COUNTY PWSD 2
- HYPOCHLORINATION, PRE

MO1010605
OREGON PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

System Treatment Processes

MO5190095
ORLEANS TRAIL RESORT
- ION EXCHANGE

MO5212752
ORLEANS TRAIL RESTAURANT
- ION EXCHANGE

MO5010606
ORONOGO PWS
- GASEOUS CHLORINATION, POST

MO3011367
OSAGE BEACH EAST PWS
- 4-LOG TREATMENT OF VIRUSES
- FLUORIDATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO3011346
OSAGE BEACH WEST PWS
- 4-LOG TREATMENT OF VIRUSES
- FLUORIDATION
- HYPOCHLORINATION, POST

MO3252600
OSAGE COMMUNITY ELKS LODGE 2705
- ION EXCHANGE

MO3024439
OSAGE COUNTY PWSD 3
- HYPOCHLORINATION, POST

MO3238092
OSAGE HERITAGE CONDOMINIUMS
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO3079537
OSAGE RIDGE APTS
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5283144
OSAGE RIVER FARM INC
- HYPOCHLORINATION, POST

MO3191738
OSAGE VILLAGE INN
- ION EXCHANGE

MO1010609
OSBORN PWS
- FILTRATION, GREENSAND
- HYPOCHLORINATION, PRE
- PERMANGANATE

MO5232120
OSCEOLA CHEESE COMPANY
- ION EXCHANGE

MO5010612
OSCEOLA PWS
- GASEOUS CHLORINATION, POST

MO3010614
OTTERVILLE PWS
- HYPOCHLORINATION, POST

MO3178192
OUR LADY OF THE SNOW SCHOOL
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5212896
OUTPOST/RANCH HOUSE
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5031070
OVERLOOK SUBDIVISION
- HYPOCHLORINATION, POST

MO6010618
OWENSVILLE PWS
- HYPOCHLORINATION, POST

MO5024444
OZARK COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO4181616
OZARK DEVELOPMENT CORP
- GASEOUS CHLORINATION, POST

MO5198285
OZARK MOUNTAIN RESORT
- GASEOUS CHLORINATION, POST

MO4102207
OZARK NATL RIVER AKERS CAMP
- HYPOCHLORINATION, POST

System Treatment Processes

MO4102205
OZARK NATL RIVER ALLEY SPRING
- HYPOCHLORINATION, POST

MO4102202
OZARK NATL RIVER BIG SPRING
- HYPOCHLORINATION, POST

MO4102208
OZARK NATL RIVER CEDARGROVE
- HYPOCHLORINATION, POST

MO4102204
OZARK NATL RIVER LOG YARD CAMP
- HYPOCHLORINATION, POST

MO4102206
OZARK NATL RIVER PULLTITE CAMP
- HYPOCHLORINATION, POST

MO4100210
OZARK NATL RIVER ROUND SPRING
- HYPOCHLORINATION, POST

MO4102203
OZARK NATL RIVER TWO RIVERS
- HYPOCHLORINATION, POST

MO5048271
OZARK PARK ESTATES
- HYPOCHLORINATION, POST

MO5010619
OZARK PWS
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, POST

MO5182750
OZARK STAVE PRODUCTS
- HYPOCHLORINATION, POST

MO5272763
OZARK UNITED METHODIST CHURCH
- FILTRATION, CARTRIDGE

MO5071342
OZARK VILLA AT SHELL KNOB
- HYPOCHLORINATION, POST

MO3190749
OZARK VILLAGE RESORT
- ION EXCHANGE

MO5036046
OZARKS CWC KIMBERLING CITY CENTER WATER
- HYPOCHLORINATION, POST

MO6010620
PACIFIC PWS
- FLUORIDATION
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6036316
PALISADES VILLAGE
- HYPOCHLORINATION, PRE

MO2010623
PALMYRA PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- RAPID MIX
- SEDIMENTATION

MO5252743
PANORAMA POINT SUBDIVISION
- HYPOCHLORINATION, POST

MO5070476
PARADISE LANDING/KIMBERLING SHORES
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, POST

MO5071269
PARADISE POINT RESORT LLC
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO3218004
PARADISE RESTAURANT
- HYPOCHLORINATION, POST

System Treatment Processes

MO4010279
PARK HILLS PWS

- 4-LOG TREATMENT OF VIRUSES
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- SEDIMENTATION

MO3282326
PARK PLACE MASTER ASSN

- ACTIVATED CARBON, GRANULAR
- FILTRATION, GREENSAND
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4048083
PARKWOOD LAKE ESTATES

- HYPOCHLORINATION, POST

MO4010626
PARMA PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, DIFFUSED
- FILTRATION, GREENSAND
- HYPOCHLORINATION, POST
- PERMANGANATE
- PH ADJUSTMENT

MO5030380
PATTERSON DUCK CLUB POA

- HYPOCHLORINATION, POST

MO5272914
PATTERSON HEIGHTS BAPTIST CHURCH

- HYPOCHLORINATION, PRE

MO4292325
PATTON JUNCTION SERVICES INC

- ION EXCHANGE

MO1010632
PATTONSBURG PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, POST
- RAPID MIX
- SEDIMENTATION

MO5283051
PEACE LUTHERAN CHURCH

- ION EXCHANGE

MO3238027
PELICAN BAY CONDOMINIUMS

- ION EXCHANGE

MO4024448
PEMISCOT COUNTY CON PWSD 1

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- SEDIMENTATION
- SLUDGE TREATMENT

MO4010636
PERRYVILLE PWS

- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION
- ULTRAVIOLET RADIATION

MO5191569
PETRO STOPPING CENTER

- HYPOCHLORINATION, POST

MO3021332
PETTIS/JOHNSON/SALINE PWSD 1

- HYPOCHLORINATION, POST

System Treatment Processes

MO6202335
PEVELY FARM GOLF CLUB
- FILTRATION, PRESSURE SAND
- FILTRATION, SLOW SAND
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6031185
PEVELY FARM HOMEOWNERS ASSN
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- INHIBITOR, POLYPHOSPHATE
- PERMANGANATE

MO6010638
PEVELY PWS
- GASEOUS CHLORINATION, POST

MO4243048
PHEASANT ACRES RV PARK LLC
- HYPOCHLORINATION, POST

MO3024466
PHELPS COUNTY PWSD 2 NORTH
- GASEOUS CHLORINATION, PRE
- SEQUESTRATION

MO3024467
PHELPS COUNTY PWSD 2 SOUTH
- GASEOUS CHLORINATION, PRE
- SEQUESTRATION

MO5292347
PHILLIPS 66 #258
- 4-LOG TREATMENT OF VIRUSES
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO4010640
PIEDMONT PWS
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5010641
PIERCE CITY PWS
- HYPOCHLORINATION, POST

MO3010642
PILOT GROVE PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST
- PH ADJUSTMENT, POST

MO4010643
PILOT KNOB PWS
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO4021451
PILOT KNOB RURAL WD 1 DOE RUN AREA
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST
- PH ADJUSTMENT, POST
- REVERSE OSMOSIS

MO6048354
PINE FORD VILLAGE MHP
- ION EXCHANGE

MO4036308
PINE TRAILS WATER CO
- HYPOCHLORINATION, PRE

MO5191610
PINE VALLEY
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4240671
PINECREST CAMP
- HYPOCHLORINATION, POST

MO5010645
PINEVILLE PWS
- FAT PIPE
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO5031540
PINNACLE SHORES SUBDIVISION
- HYPOCHLORINATION, POST

System Treatment Processes

MO5030770
PIONEER POINT SUBD
- HYPOCHLORINATION, POST

MO5211850
PIZZA HUT
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO1024478
PLATTE COUNTY PWSD 4
- HYPOCHLORINATION, PRE

MO1010648
PLATTSBURG PWS
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- SEDIMENTATION

MO5010650
PLEASANT HOPE PWS
- GASEOUS CHLORINATION, POST

MO5172058
PLEASANT VIEW SCHOOLS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3192146
POINT RANDALL RESORT
- ION EXCHANGE

MO5302865
POINTE ROYALE
- HYPOCHLORINATION, POST

MO5031554
POINTE SEVEN CONDOMINIUMS
- HYPOCHLORINATION, POST

MO3190710
POINTE VIEW RESORT
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5120165
POMME DE TERRE STATE PARK
- HYPOCHLORINATION, POST

MO3031261
PONDEROSA SUBDIVISION
- ACTIVATED CARBON, GRANULAR
- FILTRATION, RAPID SAND
- HYPOCHLORINATION, POST

MO4010656
POPLAR BLUFF PWS
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO3190813
PORT ARROWHEAD
- ION EXCHANGE

MO5112272
PORT OF KIMBERLING MARINA & CMPGRD 119
- HYPOCHLORINATION, POST

MO5111968
PORT OF KIMBERLNG MARINA & CMPGRND 117
- HYPOCHLORINATION, POST

MO5112271
PORT OF KIMBERLNG MARINA & CMPGRND 118
- HYPOCHLORINATION, POST

MO4036132
PORT PERRY SERVICE
- HYPOCHLORINATION, POST

System Treatment Processes

MO6010657
PORTAGE DES SIOUX PWS
- AERATION, CASCADE
- FILTRATION, GREENSAND
- HYPOCHLORINATION, POST
- ION EXCHANGE
- PERMANGANATE

MO4010658
PORTAGEVILLE PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT
- SEDIMENTATION

MO6069096
POTOSI EAST
- HYPOCHLORINATION, POST

MO6010659
POTOSI PWS
- HYPOCHLORINATION, POST

MO5283019
PRAIRIE CHAPEL UMC
- ION EXCHANGE

MO5172099
PRAIRIE GROVE SCHOOL
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO5036140
PRAIRIE HEIGHTS SUBD
- HYPOCHLORINATION, POST

MO3010660
PRAIRIE HOME PWS
- HYPOCHLORINATION, POST

MO2010664
PRINCETON PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO6292691
PRO STOP
- ION EXCHANGE

MO4180589
PROCTER & GAMBLE PAPER PROD CO
- HYPOCHLORINATION, PRE

MO6272942
PROSPECT BAPTIST CHURCH LONEDELL
- ION EXCHANGE

MO5292997
PUMP N PANTRY OF DIAMOND
- HYPOCHLORINATION, POST

MO5010665
PURCELL PWS
- HYPOCHLORINATION, POST

MO5010667
PURDY PWS
- HYPOCHLORINATION, POST

MO5021292
PWSD 2 OF HICKORY CO
- HYPOCHLORINATION, POST

MO5021421
PWSD 2 OF STONE COUNTY 265
- GASEOUS CHLORINATION, POST

MO5030183
QUAIL COVE SUBDIVISION
- HYPOCHLORINATION, POST

MO5048365
QUAIL CREEK MOBILE HOME PARK
- HYPOCHLORINATION, PRE

MO6031327
QUAIL RUN MHP
- HYPOCHLORINATION, POST

MO3190760
QUAILS NEST INN & SUITES
- ION EXCHANGE

System Treatment Processes

MO3258265
QUICK STOP
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5036007
QUIET COVE SUBD
- HYPOCHLORINATION, POST

MO5292791
QUIET SIDE QUIK MART
- ACTIVATED CARBON, GRANULAR
- FILTRATION, CARTRIDGE

MO4010670
QULIN PWS
- HYPOCHLORINATION, PRE

MO5272957
RACINE CHRISTIAN CHURCH
- ION EXCHANGE

MO6036271
RAINTREE PLANTATION
- HYPOCHLORINATION, POST

MO2024499
RALLS COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO4180578
RAPCO HORIZON COUNTY
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO5258138
RAPID ROBERTS 104
- HYPOCHLORINATION, POST

MO5291277
RAPID ROBERTS 106
- ACTIVATED CARBON, GRANULAR
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5292575
RAPID ROBERTS 121
- ULTRAVIOLET RADIATION

MO1010673
RAVENWOOD PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- COAGULATION
- FILTRATION, PRESSURE SAND
- FLOCCULATION
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- SEDIMENTATION
- SLUDGE TREATMENT

MO1024511
RAY COUNTY CONS PWSD 2
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5048130
RDE WATER COMPANY
- HYPOCHLORINATION, POST

MO4211659
RED CEDAR LODGE
- ION EXCHANGE

MO5193115
RED CEDAR MOTEL AND RV PARK
- HYPOCHLORINATION, POST

MO5030930
RED CEDAR PT HOMEOWNERS ASSN INC
- HYPOCHLORINATION, POST

MO3212446
RED FOX BAR & GRILL
- FILTRATION, CARTRIDGE
- ION EXCHANGE
- ULTRAVIOLET RADIATION

System Treatment Processes

MO5048346
RED OAK ESTATES
- HYPOCHLORINATION, POST

MO5031416
RED OAK SUBDIVISION
- ION EXCHANGE

MO5010678
REDINGS MILL PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5010679
REEDS SPRING PWS
- HYPOCHLORINATION, POST

MO3190260
REEL & TRIGGER RESORT
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO5010681
REPUBLIC PWS
- FLUORIDATION
- GASEOUS CHLORINATION, POST

MO4024516
REYNOLDS COUNTY PWSD 1
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- SEDIMENTATION

MO3011121
RHINELAND PWS
- HYPOCHLORINATION, POST

MO4211072
RHODES 101 CONVENIENCE STORE
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO1010682
RICH HILL PWS
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PH ADJUSTMENT
- RAPID MIX
- SEDIMENTATION

MO1010685
RICHMOND PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX

MO3291408
RICKS C STORE & MORE
- ION EXCHANGE

MO4036224
RIDGETOP WATERWORKS CORP SUBDIVISION
- HYPOCHLORINATION, POST

MO4024522
RIPLEY COUNTY PWSD 1 WEST
- HYPOCHLORINATION, POST

MO4024523
RIPLEY COUNTY PWSD 2
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO4010689
RISCO PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SPRAY
- HYPOCHLORINATION, POST

MO5161591
RITTER SPRINGS PARK
- HYPOCHLORINATION, POST

MO6293185
RIVER EDGE GASMART
- ACTIVATED CARBON, GRANULAR
- ION EXCHANGE
- PEROXIDE
- ULTRAVIOLET RADIATION

System Treatment Processes

MO5036315
RIVERFORK RANCH ESTATES
- HYPOCHLORINATION, POST

MO3190266
RIVERS END MOTEL
- ION EXCHANGE

MO6112781
RIVERS PROJECT OFFICE
- ACTIVATED CARBON, GRANULAR
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5031106
RIVERSIDE PARK 2ND ADD
- HYPOCHLORINATION, POST

MO3069003
RIVERVIEW NURSING CENTER
- ION EXCHANGE

MO3248179
RIVERVIEW RV PARK
- ION EXCHANGE

MO5036314
RIVIERA SOUTH WATER CORP
- HYPOCHLORINATION, POST

MO5303169
ROANDA BEACH CONDOS
- ION EXCHANGE

MO5031084
ROARING RIVER HOMEOWNERS ASSN INC
- HYPOCHLORINATION, POST

MO5120166
ROARING RIVER STATE PARK
- FAT PIPE
- HYPOCHLORINATION, POST

MO6120577
ROBERTSVILLE STATE PARK
- HYPOCHLORINATION, POST

MO5190955
ROCK LANE RESORT
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5191535
ROCK VIEW RESORT
- ION EXCHANGE

MO5010697
ROCKAWAY BEACH PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5191567
ROD N REEL RESORT
- HYPOCHLORINATION, POST

MO5010699
ROGERSVILLE PWS
- GASEOUS CHLORINATION, POST

MO4036318
ROGUE CREEK UTILITIES
- ION EXCHANGE

MO3221427
ROLLA NATIONAL AIRPORT
- HYPOCHLORINATION, PRE

MO3010700
ROLLA PWS
- FLUORIDATION
- GASEOUS CHLORINATION, PRE

MO5036319
ROLLIN ACRES SUBDIVISION
- HYPOCHLORINATION, POST

MO3202562
ROLLING HILLS COUNTRY CLUB
- ACTIVATED CARBON, GRANULAR
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5048344
ROLLING MEADOWS
- HYPOCHLORINATION, POST

MO4211606
ROSENERS MOTEL
- ION EXCHANGE

System Treatment Processes

MO5040057
ROXBOROUGH MHP
- 4-LOG TREATMENT OF VIRUSES
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO6251710
ROY L UTILITIES
- HYPOCHLORINATION, POST

MO4031334
ROYAL LAKE ESTATES
- FLUORIDATION
- HYPOCHLORINATION, PRE

MO5301407
ROYALE PALMS
- ION EXCHANGE

MO4292751
ROYS #7
- ION EXCHANGE

MO5292331
ROYS STORE
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3010706
RUSSELLVILLE PWS
- HYPOCHLORINATION, POST

MO4240120
S F SCOUT RANCH
- 3-LOG REMOVE/INACTIV G LAMBLIA
- 4-LOG TREATMENT OF VIRUSES
- 5.5-LOG REMOVE/INACTIV CRYPTO
- COAGULATION
- FILTRATION, ULTRAFILTRATION
- FLOCCULATION
- HYPOCHLORINATION, POST
- PH ADJUSTMENT
- SEDIMENTATION

MO4036226
S K & M WATER COUNTY INC
- HYPOCHLORINATION, PRE

MO5282624
SADDLEBROOKE VISITOR CENTER
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO5273106
SAFE HAVEN MENNONITE CHURCH
- ION EXCHANGE

MO5273216
SAGMOUNT BAPTIST YOUTH CAMP
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4010721
SALEM PWS
- GASEOUS CHLORINATION, POST
- HYPOCHLORINATION, POST

MO4182302
SALEM WOOD PRODUCTS
- HYPOCHLORINATION, POST

MO2010722
SALISBURY PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5210911
SAND SPRING RESORT & CANOE LLC
- ION EXCHANGE

MO5031369
SANS SOUCI HOA
- HYPOCHLORINATION, POST

MO5010723
SARCOXIE PWS
- FLUORIDATION
- HYPOCHLORINATION, POST

System Treatment Processes

MO1010724
SAVANNAH PWS
4-LOG TREATMENT OF VIRUSES
AERATION, SLAT TRAY
COAGULATION
FILTRATION, RAPID SAND
FLOCCULATION
FLUORIDATION
GASEOUS CHLORINATION, POST
GASEOUS CHLORINATION, PRE
LIME - SODA ASH ADDITION
PH ADJUSTMENT, PRE

MO5036350
SCHOONER BAY LANDING SUBDIVISION
HYPOCHLORINATION, POST

MO5190956
SCHOONER CREEK RESORT
HYPOCHLORINATION, POST

MO5211245
SCOOPS & MORE
FILTRATION, CARTRIDGE
ION EXCHANGE
ULTRAVIOLET RADIATION

MO6036062
SCOTSDALE SUBD
HYPOCHLORINATION, PRE

MO4010726
SCOTT CITY PWS
4-LOG TREATMENT OF VIRUSES
AERATION, SPRAY
COAGULATION
FILTRATION, GREENSAND
FLOCCULATION
FLUORIDATION
GASEOUS CHLORINATION, POST
GASEOUS CHLORINATION, PRE
PERMANGANATE

MO4021566
SCOTT COUNTY PWSD 4
FILTRATION, GREENSAND
GASEOUS CHLORINATION, POST
GASEOUS CHLORINATION, PRE
PERMANGANATE
PH ADJUSTMENT, POST

MO5258124
SCOTTS ICONIUM STORE
FILTRATION, CARTRIDGE
HYPOCHLORINATION, POST
ION EXCHANGE

MO3010728
SEDALIA PWS
ACTIVATED CARBON, GRANULAR
CHLORAMINES
FILTRATION, RAPID SAND
FLUORIDATION
GASEOUS CHLORINATION, POST
HYPOCHLORINATION, POST
LIME - SODA ASH ADDITION
PERMANGANATE
RAPID MIX

MO4010729
SEDGEWICKVILLE PWS
HYPOCHLORINATION, POST

MO5271645
SELMORE BAPTIST CHURCH
FILTRATION, CARTRIDGE
ION EXCHANGE

MO4010732
SENATH PWS
HYPOCHLORINATION, POST

MO5010733
SENECA PWS
FAT PIPE
HYPOCHLORINATION, POST

MO5173099
SENECA R 7 EARLY CHILDHOOD CENTER
HYPOCHLORINATION, POST

System Treatment Processes

MO6293163
SERVGAS FAST MART
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO5212937
SEVEN SPRINGS WINERY
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO3031220
SEVEN TRAILS WEST SUBD
- HYPOCHLORINATION, POST

MO5192929
SHADY ACRE MOTEL
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5048013
SHADY ACRES MHP
- HYPOCHLORINATION, POST

MO5240236
SHADY BEACH CAMPGROUND
- HYPOCHLORINATION, POST

MO4210857
SHAMROCK REST & LOUNGE
- HYPOCHLORINATION, PRE

MO5250538
SHAWNEE WOODS SUBD
- HYPOCHLORINATION, POST

MO2010736
SHELBINA PWS
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT
- SEDIMENTATION

MO5010738
SHELDON PWS
- GASEOUS CHLORINATION, POST

MO5036168
SHELL ROCK UTILITIES
- HYPOCHLORINATION, POST

MO5270521
SHEPHERD HILLS LUTHERAN CHURCH
- ION EXCHANGE

MO5211955
SHEPHERD OF THE HILLS
- HYPOCHLORINATION, POST

MO5142186
SHEPHERD OF THE HILLS HATCHERY
- HYPOCHLORINATION, POST

MO1010739
SHERIDAN PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, PRESSURE SAND
- HYPOCHLORINATION, PRE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5036265
SHERWOOD SUBD OWNER ASSN
- HYPOCHLORINATION, POST

MO5182899
SHO ME POWER ELECTRIC COOP
- ION EXCHANGE

MO5199988
SHORE ACRES RESORT
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5241299
SHORELINE CAMPGROUND AND RESORT
- HYPOCHLORINATION, POST

MO1061484
SHOW ME CHRISTIAN YOUTH HOME
- HYPOCHLORINATION, POST
- ION EXCHANGE

System Treatment Processes

MO5262776
SHOW ME SHORES
- HYPOCHLORINATION, POST

MO5301497
SIERRA BAY CONDOMINIUMS
- HYPOCHLORINATION, POST

MO4010743
SIKESTON PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, DIFFUSED
- AERATION, SLAT TRAY
- FILTRATION, GREENSAND
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT
- PH ADJUSTMENT, PRE
- SEDIMENTATION

MO6010902
SILEX PWS
- HYPOCHLORINATION, POST
- SEQUESTRATION

MO5031210
SILO RIDGE
- HYPOCHLORINATION, POST

MO5252603
SILVER BELL SUBDIVISION HOA INC
- HYPOCHLORINATION, POST

MO5201957
SILVER DOLLAR CITY MARVEL CAVE
- HYPOCHLORINATION, POST

MO5272988
SILVER MOON FULL GOSPEL CHURCH
- HYPOCHLORINATION, POST

MO6203148
SILVER OAKS
- ION EXCHANGE

MO5181763
SIMMONS FOODS INC
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE

MO6181967
SIX FLAGS ST LOUIS
- HYPOCHLORINATION, POST

MO5171803
SKYLINE ELEMENTARY SCHOOL
- ION EXCHANGE

MO3190728
SKYLINE RESORT
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5303170
SKYWATER ESTATES #1
- ULTRAVIOLET RADIATION

MO2010745
SLATER PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, PACKED TOWER
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO2181076
SMITHFIELD FARMLAND CORP
- ACTIVATED CARBON, POWDERED
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

System Treatment Processes

MO3010746
SMITHTON PWS
- HYPOCHLORINATION, POST

MO1010748
SMITHVILLE PWS
- ACTIVATED CARBON, POWDERED
- CHLORINE DIOXIDE
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO3171252
SOUTH CALLAWAY COUNTY R II SCHOOLS
- ION EXCHANGE

MO4171176
SOUTH FORK ELEMENTARY SCHOOL
- HYPOCHLORINATION, PRE

MO5010749
SOUTH GREENFIELD PWS
- HYPOCHLORINATION, POST

MO5071255
SOUTHPORT CONDOMINIUMS
- HYPOCHLORINATION, POST

MO5010751
SOUTHWEST CITY PWS
- GASEOUS CHLORINATION, POST

MO5010752
SPARTA PWS
- FAT PIPE
- HYPOCHLORINATION, POST

MO3182551
SPEEDLINE TECHNOLOGIES INC
- ION EXCHANGE

MO3190833
SPINNAKER POINT
- ION EXCHANGE

MO5031093
SPOKANE HIGHLANDS
- HYPOCHLORINATION, POST

MO5171596
SPOKANE R VII SCHOOLS
- HYPOCHLORINATION, POST

MO3190753
SPORTSMANS HARBOR CONDOMINIUMS
- ION EXCHANGE

MO5010754
SPRINGFIELD PWS
- ACTIVATED CARBON, POWDERED
- COAGULATION
- FILTRATION, CARTRIDGE
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- HYPOCHLORINATION, POST
- ION EXCHANGE
- LIME - SODA ASH ADDITION
- PERMANGANATE
- PH ADJUSTMENT, POST
- SEDIMENTATION

MO5210110
SPRINGFIELD SKATELAND
- HYPOCHLORINATION, POST
- ULTRAVIOLET RADIATION

MO6222456
ST CHARLES COUNTY AIRPORT
- ION EXCHANGE

System Treatment Processes

MO6024530
ST CHARLES COUNTY PWSD 2
- 4-LOG TREATMENT OF VIRUSES
- AERATION, DIFFUSED
- FILTRATION, RAPID SAND
- FLUORIDATION
- HYPOCHLORINATION, POST
- LIME - SODA ASH ADDITION
- RAPID MIX
- SEQUESTRATION

MO6024531
ST CHARLES COUNTY PWSD 2 AUGUSTA
- HYPOCHLORINATION, POST

MO6024628
ST CHARLES COUNTY PWSD 2 DUTZOW
- HYPOCHLORINATION, POST

MO6021531
ST CHARLES COUNTY PWSD 2 HICKORY TRAILS
- HYPOCHLORINATION, POST

MO6021633
ST CHARLES COUNTY PWSD 2 NORTH OAK DR
- HYPOCHLORINATION, POST
- SEQUESTRATION

MO6031209
ST CHARLES COUNTY PWSD 2 SUMAC RIDGE
- HYPOCHLORINATION, POST

MO6024629
ST CHARLES COUNTY PWSD 2 WARREN
- HYPOCHLORINATION, POST
- SEQUESTRATION

MO6010707
ST CHARLES PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, PACKED TOWER
- CHLORAMINES
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- INHIBITOR, HEXAMETAPHOSPHATE
- LIME - SODA ASH ADDITION
- RAPID MIX
- SEDIMENTATION

MO6010287
ST CHARLES PWSD 2 FORISTELL
- HYPOCHLORINATION, POST
- SEQUESTRATION

MO4202962
ST FRANCOIS COUNTRY CLUB INC
- ION EXCHANGE

MO4120167
ST FRANCOIS STATE PARK
- HYPOCHLORINATION, POST

MO6172414
ST IGNATIUS LOYOLA SCHOOL
- ION EXCHANGE

MO4122074
ST JOE STATE PARK
- HYPOCHLORINATION, POST

MO6173056
ST JOSEPH PARISH
- ION EXCHANGE

MO4180658
ST JUDE INDUSTRIAL PARK
- 4-LOG TREATMENT OF VIRUSES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- LIME - SODA ASH ADDITION
- SEDIMENTATION

MO6010715
ST LOUIS CITY PWS
- CHLORAMINES
- FILTERED
- FILTRATION, RAPID SAND
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- SEDIMENTATION
- SLUDGE TREATMENT

System Treatment Processes

MO4010718
ST MARY PWS
- HYPOCHLORINATION, POST

MO4069016
ST MARYS SEMINARY
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6281285
ST PAUL KNIGHTS OF COLUMBUS HALL
- HYPOCHLORINATION, POST

MO6011535
ST PAUL PWS
- HYPOCHLORINATION, POST

MO6171217
ST PAULS ELEMENTARY SCHOOL
- ACTIVATED CARBON, GRANULAR
- HYPOCHLORINATION, POST

MO6010719
ST PETERS PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, CASCADE
- CHLORAMINES
- FILTRATION, RAPID SAND
- FLUORIDATION
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, POST
- RAPID MIX
- SEDIMENTATION

MO3010720
ST ROBERT PWS
- FLUORIDATION

MO5030473
STARLIGHT VILLAGE
- HYPOCHLORINATION, POST

MO4218505
STARLITE DRIVE IN THEATRE
- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO3048123
STATELY MANSION MOBILE VILLA
- HYPOCHLORINATION, POST

MO4010710
STE GENEVIEVE PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT
- PH ADJUSTMENT, PRE

MO4010758
STEELE PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- RAPID MIX
- SEDIMENTATION

MO5010760
STELLA PWS
- HYPOCHLORINATION, POST

MO4170524
STEPPING STONES PRESCHOOL & DAYCARE
- HYPOCHLORINATION, POST

MO3212564
STEVES FAMILY STYLE RESTAURANT
- ION EXCHANGE

System Treatment Processes

MO3031259
STILLWATER SUBDIVISION
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5190969
STILLWATERS RESORT INC
- HYPOCHLORINATION, POST

MO5010763
STOCKTON PWS
- HYPOCHLORINATION, POST

MO5122154
STOCKTON STATE PARK CAMPGRD
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO5122650
STOCKTON STATE PARK OFFICE
- FILTRATION, CARTRIDGE

MO4024581
STODDARD COUNTY PWSD 1
- 4-LOG TREATMENT OF VIRUSES
- AERATION, DIFFUSED
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO4024582
STODDARD COUNTY PWSD 2
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5024590
STONE COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO5271012
STONECROFT CONFERENCE CENTER
- HYPOCHLORINATION, POST

MO5041213
STONES MHP
- HYPOCHLORINATION, POST

MO5192523
STONEWATER COVE RESORT
- HYPOCHLORINATION, PRE

MO3069089
STONEY RIDGE VILLAGE
- ION EXCHANGE

MO5191952
STONY BROOK INN
- HYPOCHLORINATION, POST

MO5010765
STOTTS CITY PWS
- HYPOCHLORINATION, POST

MO3010767
STOVER PWS
- HYPOCHLORINATION, POST

MO5010768
STRAFFORD PWS
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO5218155
SUBWAY
- HYPOCHLORINATION, POST

MO3031211
SUGAR TREE CLUB
- HYPOCHLORINATION, POST

MO5213079
SUGARFOOT BARBEQUE
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO2024594
SULLIVAN COUNTY PWSD 1
- HYPOCHLORINATION, POST

MO6010775
SULLIVAN PWS
- AERATION, DIFFUSED
- GASEOUS CHLORINATION, POST
- SEQUESTRATION

MO5301431
SUMMER HILL CONDOMINIUM ASSN INC
- HYPOCHLORINATION, POST

MO3031257
SUMMER PLACE ON THE LAKE
- HYPOCHLORINATION, POST

System Treatment Processes

MO6036031
SUMMER SET UTILITY CO
- HYPOCHLORINATION, POST

MO4010777
SUMMERSVILLE PWS
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5030209
SUNDOWN WATER SYSTEM INC
- HYPOCHLORINATION, POST

MO6180570
SUNEDISON SEMICONDUCTOR
- HYPOCHLORINATION, POST

MO5031591
SUNRISE BEACH VILLAGE OF PWS
- HYPOCHLORINATION, POST

MO6036080
SUNRISE LAKES SUBD
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO3238193
SUNRISE POINT
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO6171184
SUNRISE R IX ELEMENTARY SCHOOL
- ION EXCHANGE

MO3238025
SUNRISE RIDGE CONDO
- ION EXCHANGE

MO3190730
SUNSET BEACH RESORT
- ION EXCHANGE

MO5280547
SUNSET DRIVE IN
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5036054
SUNSET HEIGHTS 2ND ADDITION
- HYPOCHLORINATION, POST

MO5036092
SUNSET HEIGHTS SUBD WELL 2 BLOCK 2
- HYPOCHLORINATION, POST

MO3190770
SUNSET INN RESORT
- HYPOCHLORINATION, PRE

MO5048021
SUNSET MHP
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO4190876
SUNSET POINT RESORT
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO5252902
SUNSET SHORES
- HYPOCHLORINATION, POST

MO5170939
SUNSHINE CHILDRENS HOME
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5031606
SUNSHINE ESTATES
- HYPOCHLORINATION, POST

MO5036150
SUSSEX PARK SUBD
- HYPOCHLORINATION, POST

MO5031340
SWEETWATER BEACH SUBD
- HYPOCHLORINATION, POST

MO5036253
SYCAMORE LANDING ASSN
- HYPOCHLORINATION, POST

MO5031437
SYCAMORE RIDGE SUBDIVISION
- HYPOCHLORINATION, POST

MO6048401
SYCAMORE SPRINGS
- HYPOCHLORINATION, POST

System Treatment Processes

MO3031280
SYLVAN BAY SUBDIVISION
- HYPOCHLORINATION, POST

MO5211225
T & R SOUTHWESTERN CAFE
- HYPOCHLORINATION, POST

MO5030442
TABLE ROCK HEIGHTS HOME OWNERS ASSN
- HYPOCHLORINATION, POST

MO5069084
TABLE ROCK RETIREMENT VILLAGE
- HYPOCHLORINATION, POST

MO5238059
TABLE ROCK SPORTSMENS CLUB
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5120169
TABLE ROCK STATE PARK
- HYPOCHLORINATION, POST

MO5111946
TABLE ROCK VINEY CREEK 105
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO5272979
TALKING ROCKS ROAD BAPTIST CHURCH
- HYPOCHLORINATION, POST

MO5241443
TALL PINES CAMPGROUND
- HYPOCHLORINATION, POST

MO5218299
TANEY COUNTY MEMORIAL POST 5168
- FILTRATION, CARTRIDGE

MO5029099
TANEY COUNTY PWSD #2 - CEDAR MEADOWS
- HYPOCHLORINATION, POST

MO5024600
TANEY COUNTY PWSD 2
- GASEOUS CHLORINATION, POST

MO5024602
TANEY COUNTY PWSD 3
- HYPOCHLORINATION, POST

MO5036223
TANEY COUNTY WATER LLC LAKEWAY
- HYPOCHLORINATION, POST

MO5036180
TANEY COUNTY WATER LLC VENICE
- HYPOCHLORINATION, POST

MO5031159
TANEYCOMO HIGHLANDS SUBD INC
- HYPOCHLORINATION, POST

MO5191032
TANEYCOMO LAKEFRONT RESORT
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5191030
TANGLEWOOD LODGE
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3048124
TANGLEWOOD MOBILE COURT
- HYPOCHLORINATION, PRE

MO5213161
TAP & GRILL LAKESIDE BREW HAUS
- ION EXCHANGE

MO6036136
TARA OAKS MANOR ASSN
- ION EXCHANGE

MO5180605
TARSCO BOLTED TANK
- FILTRATION, CARTRIDGE
- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO3211033
TATERHOGGZ LLC
- ION EXCHANGE

MO4121412
TAUM SAUK STATE PARK
- HYPOCHLORINATION, PRE

System Treatment Processes

MO6282572
TEEN CHALLENGE OF ST LOUIS
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4283101
TERRACE OF FRENCH VILLAGE
- ION EXCHANGE

MO4036059
TERRE DU LAC
- HYPOCHLORINATION, POST
- HYPOCHLORINATION, PRE

MO5213090
TERRYS CAFE
- HYPOCHLORINATION, POST

MO4024608
TEXAS COUNTY PWSD 3
- HYPOCHLORINATION, POST

MO4024609
TEXAS COUNTY PWSD 4
- GASEOUS CHLORINATION, POST

MO4010788
THAYER PWS
- HYPOCHLORINATION, POST

MO3211428
THE 5 DINER
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO3218036
THE BLUE HERON RESTAURANT
- ION EXCHANGE

MO3238250
THE BREAKERS CONDOMINIUM
- ION EXCHANGE

MO3238097
THE FALLS CONDOMINIUMS
- ION EXCHANGE

MO5036218
THE LANDING SUBDIVISION
- HYPOCHLORINATION, POST

MO5252641
THE PENINSULA SUBD
- HYPOCHLORINATION, POST

MO5212501
THE ROCKS LAKESIDE GRILL AND LOUNGE
- ION EXCHANGE

MO5272956
THE SUMMIT CHURCH
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO5202810
THE TIMBERS RESORT AND LODGE
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ULTRAVIOLET RADIATION

MO5031482
THE VILLAS OF HARBOUR HILLS
- HYPOCHLORINATION, POST

MO5048099
THE WILLOWS UTILITY COMPANY
- HYPOCHLORINATION, POST

MO5191387
THEODOSIA MARINA RESORT INC
- HYPOCHLORINATION, POST

MO6213036
THIES FARM
- ACTIVATED CARBON, GRANULAR
- FILTRATION, GREENSAND
- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO3292561
THOMAS QUICK STOP
- ULTRAVIOLET RADIATION

MO5031397
THREE HILLS SUBDIVISION
- FAT PIPE
- HYPOCHLORINATION, POST

System Treatment Processes

MO5291270
TIFF STORE
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO6191991
TIMBER CREEK RESORT
- HYPOCHLORINATION, POST

MO6031217
TIMBER RIDGE ESTATES
- HYPOCHLORINATION, POST

MO3031365
TIMBERLAKE MASTER ASSN INC
- HYPOCHLORINATION, POST

MO5048274
TIMBERLOST MHP
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO5211485
TIMBEROC VILLAGE SHOPPING CENTER
- ION EXCHANGE

MO3010791
TIPTON PWS
- HYPOCHLORINATION, POST

MO3211391
TIREBITERS
- ION EXCHANGE

MO3211085
TLC ONE STOP
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5212926
TONYS PIZZA
- FILTRATION, CARTRIDGE

MO5202075
TOP OF THE ROCK GOLF COURSE
- ACTIVATED CARBON, GRANULAR
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO5048224
TOWN & COUNTRY MHP
- HYPOCHLORINATION, POST

MO5212933
TRAFFIC JAM
- ION EXCHANGE

MO4120180
TRAIL OF TEARS ST PARK VISITOR CENTER
- HYPOCHLORINATION, PRE

MO4120170
TRAIL OF TEARS STATE PARK CAMPGRD
- HYPOCHLORINATION, PRE

MO5036352
TREEHOUSE CONDOMINIUMS
- HYPOCHLORINATION, POST

MO2010796
TRENTON MUNICIPAL UTILITIES
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT
- RAPID MIX
- SEDIMENTATION

MO1071079
TRI COUNTY WATER AUTHORITY
- AERATION, SLAT TRAY
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO5190994
TRIBESMAN RESORT
- HYPOCHLORINATION, POST
- ION EXCHANGE

System Treatment Processes

MO5172890
TRINITY LEARNING CENTER
- HYPOCHLORINATION, POST

MO5191018
TROUT HOLLOW LODGE
- ACTIVATED CARBON, GRANULAR
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO6010798
TROY PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, PACKED TOWER
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, POST

MO6010799
TRUESDALE PWS
- HYPOCHLORINATION, POST

MO3242598
TRUMAN DAM RV PARK
- HYPOCHLORINATION, POST

MO3218211
TS FISH TALES BAR & GRILL
- HYPOCHLORINATION, POST

MO6036053
TUK LLC
- HYPOCHLORINATION, POST

MO5036312
TURNER ESTATES SUBD
- HYPOCHLORINATION, POST

MO5301390
TUSCANY CONDOMINIUMS
- HYPOCHLORINATION, POST

MO3292544
TUSCUMBIA EAGLE STOP
- FILTRATION, CARTRIDGE

MO5031277
TWILITE HOME SITES
- HYPOCHLORINATION, POST

MO5241141
TWIN BRIDGES CANOE AND CAMPGROUND
- HYPOCHLORINATION, POST

MO4181541
TWIN CITIES INDUSTRIAL CORRIDOR INC
- HYPOCHLORINATION, POST

MO5036186
TWIN ISLAND ESTATES
- HYPOCHLORINATION, POST

MO5030088
TWIN ISLAND HGTS HOME OWNERS ASSN
- HYPOCHLORINATION, POST

MO5048032
TWIN RIDGES PARK INC
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5036195
TWIN RIVERS SUBD
- HYPOCHLORINATION, POST

MO5243143
TWO SONS CAMPGROUND
- HYPOCHLORINATION, POST

MO3180838
TYSON POULTRY INC
- GASEOUS CHLORINATION, POST

MO6282400
TYSON RESEARCH CENTER
- ACTIVATED CARBON, GRANULAR
- FILTERED
- SEDIMENTATION
- SEQUESTRATION
- ULTRAVIOLET RADIATION

MO1192722
UNCLE GABBYS MOTEL
- HYPOCHLORINATION, POST

MO5291283
UNCLE ROYS ONE STOP
- HYPOCHLORINATION, POST

System Treatment Processes

MO6010801
UNION PWS
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE

MO2010804
UNIONVILLE PWS
- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO1010921
UNITY VILLAGE
- ACTIVATED CARBON, POWDERED
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, POST
- RAPID MIX
- SEDIMENTATION

MO3069001
UNIVERSITY OF MISSOURI COLUMBIA
- 4-LOG TREATMENT OF VIRUSES
- GASEOUS CHLORINATION, PRE

MO5111998
USACE BASS PRO SHOPS LONG CREEK CAMPGRD
- HYPOCHLORINATION, PRE

MO4241970
USACE CAMP SEMO WAPPAPELLO
- HYPOCHLORINATION, POST

MO4112021
USACE CLEARWATER BLUFF VIEW 05C
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO4110276
USACE CLEARWATER BLUFF VIEW 19C
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO4112017
USACE CLEARWATER HIGHWAY K PARK 17C
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO4112578
USACE CLEARWATER HWY K WEST
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO4112020
USACE CLEARWATER OLD HIGHWAY K PARK 14
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO4112015
USACE CLEARWATER PIEDMONT PARK 01C
- HYPOCHLORINATION, PRE

MO4112019
USACE CLEARWATER RESIDENT OFFICE 15C
- HYPOCHLORINATION, PRE
- ION EXCHANGE

MO4112030
USACE CLEARWATER RIVER RD LEFT BK 10
- HYPOCHLORINATION, PRE

MO4112032
USACE CLEARWATER RIVER RD RIGHT 18C
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO4112018
USACE CLEARWATER WEBB CREEK PARK 06C
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO4112029
USACE CLEARWATER WEBB CREEK PARK 16C
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

System Treatment Processes

MO3202324
USACE LAKE OZARK RECREATION AREA
HYPOCHLORINATION, POST

MO4069053
USACE MINGO JOB CORPS CCC
GASEOUS CHLORINATION, POST
ION EXCHANGE

MO5111819
USACE NORFORK TECUMSEH PARK 31
HYPOCHLORINATION, POST

MO5111816
USACE NORFORK UDALL PARK 30
HYPOCHLORINATION, POST

MO5110091
USACE POMME DE TERRE ADMIN
FILTERED
HYPOCHLORINATION, POST

MO5110056
USACE POMME DE TERRE DAMSITE CAMP
HYPOCHLORINATION, POST

MO5112090
USACE POMME DE TERRE LIGHTFOOT LANDING
HYPOCHLORINATION, POST

MO5110096
USACE POMME DE TERRE NEMO AREA PARK
HYPOCHLORINATION, POST

MO5110099
USACE POMME DE TERRE PITTSBURG PUA
HYPOCHLORINATION, POST

MO5112095
USACE POMME DE TERRE WHEATLAND AREA
HYPOCHLORINATION, POST

MO5110199
USACE SOUTH MUTTON CREEK GROUP CAMP
HYPOCHLORINATION, POST

MO5110195
USACE STOCKTON CEDAR RIDGE PARK
HYPOCHLORINATION, POST

MO5110200
USACE STOCKTON CRABTREE COVE
HYPOCHLORINATION, POST

MO5110193
USACE STOCKTON MUTTON CREEK MARINA EAST
HYPOCHLORINATION, POST

MO5110190
USACE STOCKTON NORTH HAWKER POINT
HYPOCHLORINATION, POST

MO5110194
USACE STOCKTON NORTH RUARK BLUFF
HYPOCHLORINATION, POST

MO5110187
USACE STOCKTON ORLEANS TRAIL PARK OT A
HYPOCHLORINATION, POST

MO5110188
USACE STOCKTON ORLEANS TRAIL PARK OT B
HYPOCHLORINATION, POST

MO5110185
USACE STOCKTON ORLEANS TRAIL PARK OT D
HYPOCHLORINATION, POST

MO5110053
USACE STOCKTON PROJECT OFFICE
HYPOCHLORINATION, POST

MO5243018
USACE STOCKTON RB GROUP CAMP RUARK BLUFF
HYPOCHLORINATION, PRE

MO5110198
USACE STOCKTON SE RUARK BLUFF AREA
HYPOCHLORINATION, POST

MO5110189
USACE STOCKTON SOUTH HAWKER POINT PARK
HYPOCHLORINATION, POST

MO5110184
USACE STOCKTON STOCKTON AREA PARK
HYPOCHLORINATION, POST

System Treatment Processes

MO5110197
USACE STOCKTON WEST RUARK BLUFF
HYPOCHLORINATION, POST

MO5111969
USACE TABLE ROCK AUNTS CREEK
HYPOCHLORINATION, POST
ULTRAVIOLET RADIATION

MO5111966
USACE TABLE ROCK BAXTER PARK
HYPOCHLORINATION, POST
ULTRAVIOLET RADIATION

MO5111949
USACE TABLE ROCK BIG M MARINA
HYPOCHLORINATION, POST

MO5112269
USACE TABLE ROCK BIG M PARK
ULTRAVIOLET RADIATION

MO5110280
USACE TABLE ROCK CAMPBELL POINT 126
HYPOCHLORINATION, POST
ULTRAVIOLET RADIATION

MO5110097
USACE TABLE ROCK CAPE FAIR
HYPOCHLORINATION, POST
ULTRAVIOLET RADIATION

MO5111948
USACE TABLE ROCK EAGLE ROCK
4-LOG TREATMENT OF VIRUSES FAT PIPE
HYPOCHLORINATION, POST
ULTRAVIOLET RADIATION

MO5111944
USACE TABLE ROCK INDIAN POINT
HYPOCHLORINATION, POST
ULTRAVIOLET RADIATION

MO5110077
USACE TABLE ROCK OLD HWY 86
HYPOCHLORINATION, POST
ULTRAVIOLET RADIATION

MO5110030
USACE TABLE ROCK RESIDENT OFFICE
ULTRAVIOLET RADIATION

MO5111947
USACE TABLE ROCK VIOLA PARK
ULTRAVIOLET RADIATION

MO3112284
USACE TRUMAN THIBAUT POINT
HYPOCHLORINATION, PRE

MO3112196
USACE TRUMAN VISITOR CENTER
HYPOCHLORINATION, POST

MO4110115
USACE WAPPAPELLO RES CHAONIA CAMP
HYPOCHLORINATION, POST

MO4112213
USACE WAPPAPELLO RES OLD GREENVILLE
HYPOCHLORINATION, POST

MO5102421
USFS COBB RIDGE REC AREA
HYPOCHLORINATION, POST

MO6102180
USFS COUNCIL BLUFF CAMPGROUND
HYPOCHLORINATION, POST

MO4102223
USFS FLOAT CAMP CAMPGROUND
HYPOCHLORINATION, POST

MO4100019
USFS MARKHAM SPRING
HYPOCHLORINATION, POST

MO5100022
USFS NORTH FORK RECREATION AREA
HYPOCHLORINATION, POST

MO6100029
USFS RED BLUFF CAMPGROUND
HYPOCHLORINATION, PRE

MO4100013
USFS SILVER MINES CAMP
HYPOCHLORINATION, POST

System Treatment Processes

MO4100015
USFS SUTTON BLUFF REC AREA

- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO6036083
VALLE LAKE SUBD

- HYPOCHLORINATION, POST

MO4010811
VAN BUREN PWS

- HYPOCHLORINATION, PRE

MO2010812
VANDALIA PWS

- ACTIVATED CARBON, POWDERED
- CHLORAMINES
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- FLUORIDATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- PERMANGANATE
- PH ADJUSTMENT, PRE
- RAPID MIX
- SEDIMENTATION

MO4010814
VANDUSER PWS

- 4-LOG TREATMENT OF VIRUSES
- AERATION, DIFFUSED
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO4212391
VCA PROPERTIES LLC

- ULTRAVIOLET RADIATION

MO5252959
VENTURE VALLEY

- HYPOCHLORINATION, POST

MO5024618
VERNON COUNTY CONS PWSD 1

- 4-LOG REMOVE/INACTIV VIRUSES
- 4-LOG TREATMENT OF VIRUSES
- AERATION, PACKED TOWER
- AERATION, SPRAY
- GASEOUS CHLORINATION, POST

MO5024617
VERNON COUNTY PWSD 2

- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- GASEOUS CHLORINATION, POST

MO3010819
VERSAILLES PWS

- HYPOCHLORINATION, POST

MO5282767
VFW POST 4207

- FILTRATION, CARTRIDGE
- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO4010821
VIBURNUM PWS

- 4-LOG TREATMENT OF VIRUSES
- GASEOUS CHLORINATION, PRE

MO5191008
VICKERY RESORT CONDOMINIUMS

- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5272964
VICTORY ROAD CHURCH

- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, POST

MO3010822
VIENNA PWS

- AERATION, PACKED TOWER
- HYPOCHLORINATION, PRE

MO6213191
VILLA ANTONIO WINERY

- ION EXCHANGE

MO5191453
VILLAGE AT INDIAN POINT

- ION EXCHANGE

System Treatment Processes

MO5036205
VILLAGE OF MC CORD BEND
- HYPOCHLORINATION, POST

MO5010967
VILLAGE OF UMBER VIEW HEIGHTS PWS
- HYPOCHLORINATION, POST

MO5212905
VINNYS CAFE AND LOUNGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5212683
VIRGILS BAR & SELF STORAGE
- FILTRATION, CARTRIDGE

MO4283064
VIRGINIA VAUGHAN RENTALS
- FILTRATION, CARTRIDGE
- ULTRAVIOLET RADIATION

MO4069038
W E SEARS YOUTH CENTER
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4293034
W G ARD # 1 LLC
- ULTRAVIOLET RADIATION

MO5290224
WAGNERS ONE STOP
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO6292397
WAGNERS STORE
- FILTRATION, CARTRIDGE

MO6041184
WALKER HILL MHP
- HYPOCHLORINATION, POST

MO5010828
WALKER PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, PACKED TOWER
- HYPOCHLORINATION, POST

MO5048214
WALL EYE HAVEN MHP
- HYPOCHLORINATION, POST

MO4041308
WALNUT GROVE MHP
- ION EXCHANGE

MO6180571
WARCO MFG COMPANY
- HYPOCHLORINATION, PRE

MO4010830
WARDELL PWS
- GASEOUS CHLORINATION, POST

MO6036084
WARREN WOODS SUBD
- HYPOCHLORINATION, PRE

MO5043117
WARRENS OAKLAND PARK
- HYPOCHLORINATION, POST

MO6010834
WARRENTON PWS
- GASEOUS CHLORINATION, POST

MO3010835
WARSAW PWS
- GASEOUS CHLORINATION, PRE

MO3171247
WARSAW R IX HIGH SCHOOL
- ION EXCHANGE

MO1202872
WARSAW SHRINE CLUB
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5010837
WASHBURN PWS
- HYPOCHLORINATION, PRE

MO4283058
WASHINGTON COUNTY KNIGHTS OF COLUMBUS
- HYPOCHLORINATION, POST

MO4021447
WASHINGTON COUNTY PWSD 2
- HYPOCHLORINATION, POST

System Treatment Processes

MO6010838
WASHINGTON PWS
- HYPOCHLORINATION, POST

MO6123123
WASHINGTON STATE PARK CAMPGROUND
- FAT PIPE
- HYPOCHLORINATION, POST

MO6120173
WASHINGTON STATE PARK OFFICE
- 4-LOG TREATMENT OF VIRUSES
- HYPOCHLORINATION, PRE

MO4021311
WAYNE & BUTLER COUNTY PWSD 4
- HYPOCHLORINATION, PRE

MO4021310
WAYNE COUNTY PWSD 2
- HYPOCHLORINATION, PRE

MO3010841
WAYNESVILLE PWS
- GASEOUS CHLORINATION, PRE

MO6292800
WAYSIDE SOUTH
- ACTIVATED CARBON, GRANULAR
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5010843
WEAUBLEAU PWS
- HYPOCHLORINATION, POST

MO5010844
WEBB CITY PWS
- AERATION, SLAT TRAY
- HYPOCHLORINATION, POST

MO6212311
WEDDING BELLS
- HYPOCHLORINATION, POST

MO6010919
WELDON SPRING HEIGHTS VILLAGE PWS
- HYPOCHLORINATION, PRE

MO6213186
WEST ALTON BAR AND GRILL
- ION EXCHANGE

MO1242721
WEST CENTRAL CHRISTIAN SERVICE
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, PRE

MO4010853
WEST PLAINS PWS
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO6182498
WESTERN OIL COMPANY
- HYPOCHLORINATION, POST

MO4031453
WESTLAKE MEADOWS SUBDIVISION
- ION EXCHANGE

MO3238028
WESTON POINT CONDOS
- ION EXCHANGE

MO1010851
WESTON PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- LIME - SODA ASH ADDITION
- SEDIMENTATION

MO5171201
WESTVIEW ELEMENTARY SCHOOL
- HYPOCHLORINATION, POST

MO5010855
WHEATLAND PWS
- HYPOCHLORINATION, POST

MO5010856
WHEATON PWS
- FAT PIPE
- HYPOCHLORINATION, PRE

System Treatment Processes

MO4243202
WHIPPOORWILL LAKE FAMILY CAMPGROUND
- LIME - SODA ASH ADDITION

MO4036095
WHISPERING HILLS SUBDIVISION
- HYPOCHLORINATION, POST

MO3241399
WHISPERING WINDS BIBLE CAMP
- HYPOCHLORINATION, PRE

MO5190998
WHISPERING WOODS
- ION EXCHANGE

MO5212716
WHITE EAGLE SHOAL CREEK PLAZA
- FILTRATION, CARTRIDGE

MO5190587
WHITE EAGLE WOODS MHP
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5292355
WHITE OAK STATION # 21
- FILTRATION, CARTRIDGE

MO5258122
WHITE OAK STATION # 6
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO5048267
WHITE PINE VILLAGE
- HYPOCHLORINATION, POST

MO5201007
WHITE RIVER LANDING
- HYPOCHLORINATION, POST

MO1079501
WHITEMAN AIR BASE
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- COAGULATION
- FILTRATION, RAPID SAND
- FLOCCULATION
- GASEOUS CHLORINATION, POST
- GASEOUS CHLORINATION, PRE
- INHIBITOR, HEXAMETAPHOSPHATE
- LIME - SODA ASH ADDITION
- PH ADJUSTMENT, POST
- RAPID MIX

MO4011158
WHITEWATER/ALLENVILLE PWS
- HYPOCHLORINATION, PRE

MO5242820
WILD OAKS CAMPGROUND
- HYPOCHLORINATION, POST

MO4190878
WILDERNESS LODGE LIMITED RIVERS EDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO5031141
WILDFLOWER HOA
- HYPOCHLORINATION, POST

MO5212121
WILDFLOWER INN
- HYPOCHLORINATION, POST

MO6291618
WILDHORSE CREEK AMOCO
- ACTIVATED CARBON, GRANULAR
- HYPOCHLORINATION, POST

MO6213205
WILDSCHUETZ BROTHERS FARM
- ION EXCHANGE
- ULTRAVIOLET RADIATION

MO3242162
WILDWOOD LOT OWNERS ASSN
- HYPOCHLORINATION, POST

MO5010860
WILLARD PWS
- GASEOUS CHLORINATION, POST

MO4010861
WILLIAMSVILLE PWS
- GASEOUS CHLORINATION, PRE

MO4010862
WILLOW SPRINGS PWS
- HYPOCHLORINATION, POST

System Treatment Processes

MO5213012
WILLOWES
- FILTRATION, CARTRIDGE
- ION EXCHANGE

MO5102181
WILSON CREEK BATTLEFIELD MONUMENT
- HYPOCHLORINATION, POST

MO3191999
WILSONS RESORT HOME ASSN
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO3301348
WINDGATE ON THE LAKE CONDOS
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST

MO1010865
WINDSOR PWS
- OZONATION, PRE

MO4031196
WINDWOOD ESTATES SUBD
- HYPOCHLORINATION, PRE

MO3036121
WINEGARS TEAL BEND SUBD
- HYPOCHLORINATION, POST

MO6202399
WOLF HOLLOW GOLF CLUB
- HYPOCHLORINATION, POST

MO3240046
WONDERLAND CAMP
- ION EXCHANGE

MO3238098
WOOD CREST CONDOMINIUMS
- ION EXCHANGE

MO5031354
WOOD HAVEN SUBDIVISION
- HYPOCHLORINATION, POST

MO5036071
WOOD RIDGE ESTATES
- HYPOCHLORINATION, POST

MO4171122
WOODLAND R IV SCHOOLS
- HYPOCHLORINATION, POST

MO6282352
WORLD BIRD SANCTUARY
- HYPOCHLORINATION, POST

MO2182824
WREN ASSOCIATES
- ION EXCHANGE

MO6010874
WRIGHT CITY PWS
- HYPOCHLORINATION, POST

MO4010876
WYATT PWS
- 4-LOG TREATMENT OF VIRUSES
- AERATION, SLAT TRAY
- FILTRATION, PRESSURE SAND
- GASEOUS CHLORINATION, PRE
- SEDIMENTATION

MO6069092
WYMAN
- HYPOCHLORINATION, POST

MO5290227
Y 76 HANDI MART
- FILTRATION, CARTRIDGE

MO6232479
YACHT CLUB OF ST LOUIS
- HYPOCHLORINATION, POST
- ION EXCHANGE

MO4191055
YMCA OZARKS SPRING
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, PRE

MO3292426
Z 7 DISCOUNT FIREWORKS
- HYPOCHLORINATION, POST

MO3282519
ZACK WHEAT AMERICAN LEGION POST 624
- FILTRATION, CARTRIDGE
- HYPOCHLORINATION, POST
- ION EXCHANGE

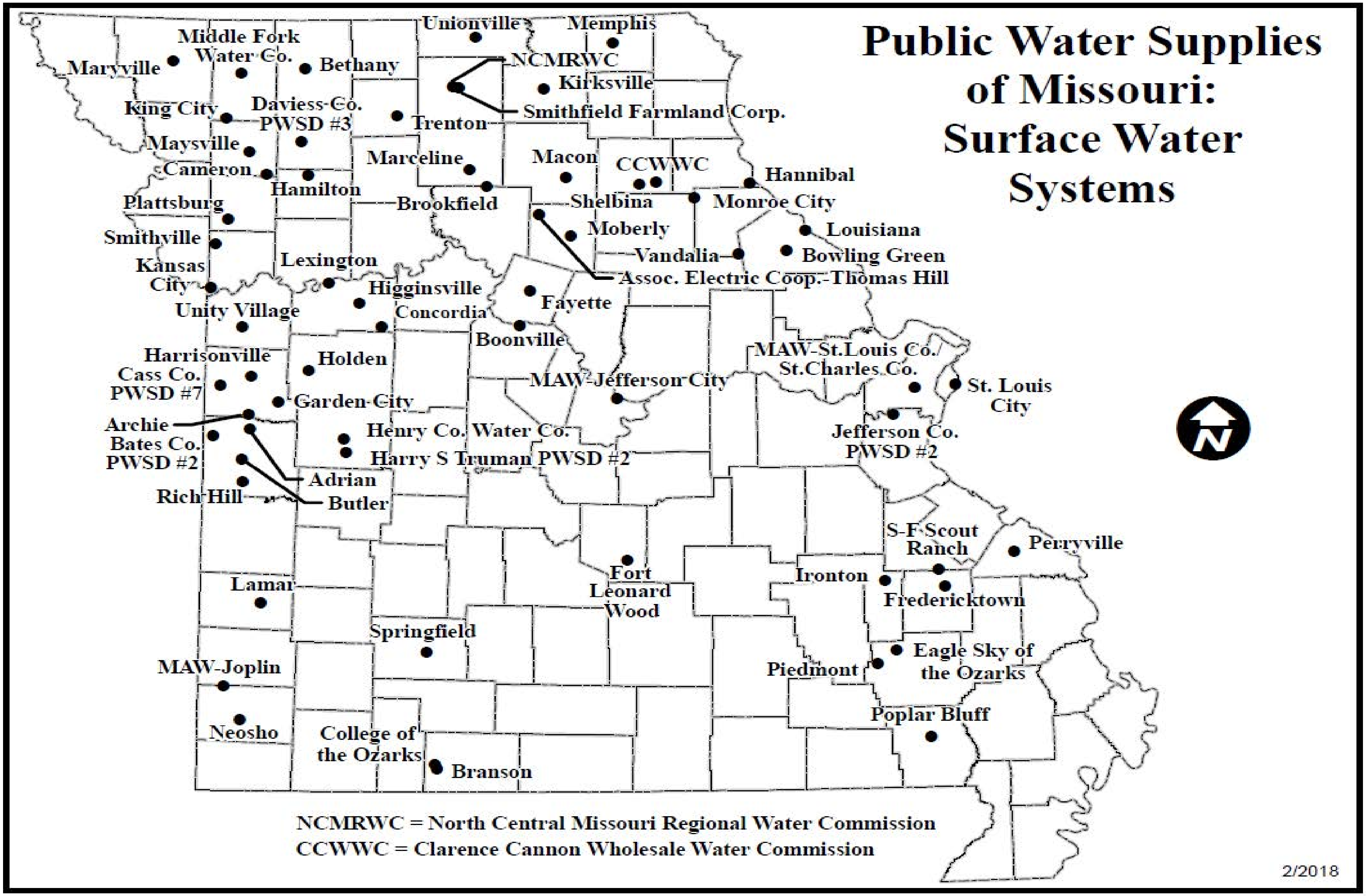
System Treatment Processes

MO4171249	
ZALMA R V SCHOOL	
	HYPOCHLORINATION, PRE
MO5242495	
ZANS CREEKSIDE CMPGRND	
	HYPOCHLORINATION, POST
MO4270507	
ZION UNITED METHODIST CHURCH	
	FILTRATION, CARTRIDGE
	ION EXCHANGE
	ULTRAVIOLET RADIATION

VI. SURFACE WATER SOURCE INFORMATION

SURFACE WATER SOURCE INFORMATION
INTRODUCTION

The surface water source information section provides a map of Missouri's surface water systems. The intake location table is by river name and then alphabetical within the river name.


Public Water Supplies of Missouri: Surface Water Systems
Maryville
Middle Fork Water Co.
Bethany
Unionville
Memphis
NCMRWC
Kirksville
Smithfield Farmland Corp.
King City
Daviess Co. PWSD #3
Trenton
Maysville
Cameron
Hamilton
Marceline
Macon
CCWWC
Hannibal
Brookfield
Shelbina
Monroe City
Plattsburg
Smithville
Moberly
Louisiana
Kansas City
Lexington
Vandalia
Bowling Green
Assoc. Electric Coop.-Thomas Hill
Higginsville
Concordia
Fayette
Unity Village
Boonville
Harrisonville
Holden
MAW-St.Louis Co./ St.Charles Co.
Cass Co. PWSD #7
MAW-Jefferson City
St. Louis City
Garden City
Archie
Henry Co. Water Co.
Jefferson Co. PWSD #2
Bates Co. PWSD #2
Harry S Truman PWSD #2
Adrian
Rich Hill
Butler
S-F Scout Ranch
Perryville
Fort Leonard Wood
Ironton
Lamar
Fredericktown
Springfield
Eagle Sky of the Ozarks
MAW-Joplin
Piedmont
Poplar Bluff
Neosho
College of the Ozarks
Branson
NCMRWC = North Central Missouri Regional Water Commission
CCWWC = Clarence Cannon Wholesale Water Commission
2/2018

Public Water System Surface Water Sources

PWS ID	System Name	Stream Name	County
Meramec River			
MO6010716	MO AMERICAN ST LOUIS ST CHARLES COUNTIES	MERAMEC RIVER SOUTH	ST LOUIS
MO6010716	MO AMERICAN ST LOUIS ST CHARLES COUNTIES	MERAMEC RIVER	ST LOUIS
Mississsippi River			
MO4010136	CAPE GIRARDEAU PWS	MISSISSIPPI RIVER	CAPE GIRARDEAU
MO2010344	HANNIBAL PWS	MISSISSIPPI RIVER	MARION
MO2010479	LOUISIANA PWS	MISSISSIPPI RIVER	PIKE
MO6010715	ST LOUIS CITY PWS	MISSISSIPPI RIVER	ST LOUIS CITY
Missouri River			
MO3010089	BOONVILLE PWS	MISSOURI RIVER	COOPER
MO1010363	HIGGINSVILLE PWS	MISSOURI RIVER	LAFAYETTE
MO1010415	KANSAS CITY PWS	MISSOURI RIVER	JACKSON
MO1010464	LEXINGTON PWS	MISSOURI RIVER	LAFAYETTE
MO3010409	MO AMERICAN JEFFERSON CITY DISTRICT	MISSOURI RIVER	COLE
MO6010716	MO AMERICAN ST LOUIS ST CHARLES COUNTIES	MISSOURI RIVER NORTH	ST LOUIS
MO6010716	MO AMERICAN ST LOUIS ST CHARLES COUNTIES	MISSOURI RIVER CENTRAL 3 & 4	ST LOUIS
MO6010716	MO AMERICAN ST LOUIS ST CHARLES COUNTIES	MISSOURI RIVER CENTRAL 1 & 2	ST LOUIS
MO6010715	ST LOUIS CITY PWS	MISSOURI RIVER	ST LOUIS CITY

Public Water System Surface Water Sources

PWS ID	System Name	Stream Name	County
Others			
MO1010001	ADRIAN PWS	SOUTH GRAND RIVER	BATES
MO1010001	ADRIAN PWS	ADRIAN LAKE	BATES
MO1010024	ARCHIE PWS	SOUTH GRAND RIVER	CASS
MO2182290	ASSOCIATED ELECTRIC THOMAS HILL 3	THOMAS HILL LAKE	RANDOLPH
MO1024031	BATES COUNTY PWSD 2	MIAMI CREEK	BATES
MO1010068	BETHANY PWS	HARRISON COUNTY LAKE INTAKE	HARRISON
MO1010068	BETHANY PWS	BETHANY NEW LAKE	HARRISON
MO1010068	BETHANY PWS	BETHANY OLD LAKE	HARRISON
MO2010093	BOWLING GREEN PWS	LAKE #2	PIKE
MO2010093	BOWLING GREEN PWS	LAKE #1	PIKE
MO5010096	BRANSON PWS	CLIFF DRIVE/LAKE TANEYCOMO	TANEY
MO5010096	BRANSON PWS	MEADOWS INTAKE/LAKE TANEYCOM	TANEY
MO2010105	BROOKFIELD PWS	BROOKFIELD LAKE	LINN
MO2010105	BROOKFIELD PWS	YELLOW CREEK	LINN
MO2010112	BUCKLIN PWS	MUSSEL FORK CREEK	LINN
MO2010112	BUCKLIN PWS	BUCKLIN LAKE	LINN
MO1010118	BUTLER PWS	MIAMI CREEK	BATES
MO1010118	BUTLER PWS	MARAIS DE CYGNE	BATES
MO1010118	BUTLER PWS	BUTLER LAKE	BATES
MO1010131	CAMERON PWS	GRINDSTONE RESERVOIR	CLINTON
MO1010131	CAMERON PWS	CAMERON RESERVOIR LAKE #3	CLINTON
MO1024111	CASS COUNTY PWSD 7	SOUTH GRAND RIVER	CASS
MO2020421	CLARENCE CANNON WHOLESALE WTR COMM	MARK TWAIN LAKE	MONROE
MO5069033	COLLEGE OF THE OZARKS	WHITE RIVER (TANEYCOMO)	TANEY
MO1010184	CONCORDIA PWS	CONCORDIA LAKE	LAFAYETTE
MO1036130	DAVIESS COUNTY PWSD 3	LAKE VIKING	DAVIESS
MO4242939	EAGLE SKY OF THE OZARKS	FRONTIER LAKE	WAYNE
MO3079500	FORT LEONARD WOOD	BIG PINEY RIVER	PULASKI
MO4010290	FREDERICKTOWN PWS	FREDERICKTOWN LAKE	MADISON
MO1010301	GARDEN CITY PWS	GARDEN CITY LAKE	CASS
MO1010301	GARDEN CITY PWS	NEW LAKE	CASS
MO1010342	HAMILTON PWS	HAMILTON LAKE	CALDWELL

Public Water System Surface Water Sources

PWS ID	System Name	Stream Name	County
MO1010342	HAMILTON PWS	MARROWBONE CREEK	CALDWELL
MO1010349	HARRISONVILLE PWS	NORTH LAKE	CASS
MO1010349	HARRISONVILLE PWS	HARRISONVILLE LAKE	CASS
MO1024247	HARRY S TRUMAN PWSD 2	TRUMAN RESERVOIR	HENRY
MO1010177	HENRY COUNTY WATER COMPANY	TRUMAN LAKE/QUARRY INTAKE	HENRY
MO1010363	HIGGINSVILLE PWS	HIGGINSVILLE LAKE	LAFAYETTE
MO1010371	HOLDEN PWS	HOLDEN LAKE	JOHNSON
MO4010402	IRONTON PWS	SHEPHERD MOUNTAIN LAKE	IRON
MO6024293	JEFFERSON COUNTY PWSD 2	BIG RIVER	JEFFERSON
MO1010425	KING CITY PWS	KING CITY LAKE	GENTRY
MO1010425	KING CITY PWS	KING CITY SOUTH LAKE	GENTRY
MO2010429	KIRKSVILLE PWS	HAZEL CREEK LAKE	ADAIR
MO2010429	KIRKSVILLE PWS	FOREST LAKE	ADAIR
MO5010446	LAMAR PWS	LAMAR LAKE	BARTON
MO2010487	MACON PWS	LONG BRANCH LAKE	MACON
MO2010497	MARCELINE PWS	OLD MARCELINE LAKE	LINN
MO2010497	MARCELINE PWS	MARCELINE LAKE	LINN
MO2010497	MARCELINE PWS	MUSSEL FORK CREEK	LINN
MO1010508	MARYVILLE PWS	MARYVILLE RESERVOIR	NODAWAY
MO1010508	MARYVILLE PWS	MOZINGO LAKE	NODAWAY
MO1010510	MAYSVILLE PWS	WILLOWBROOK LAKE	DEKALB
MO2010513	MEMPHIS PWS	MEMPHIS OLD LAKE	SCOTLAND
MO2010513	MEMPHIS PWS	MEMPHIS NEW LAKE	SCOTLAND
MO1070639	MIDDLE FORK WATER CO	LAKE ELIZABETH MIDDLE FORK WAT	GENTRY
MO5010413	MO AMERICAN JOPLIN	SHOAL CREEK	JASPER
MO2010533	MOBERLY PWS	SUGAR CREEK LAKE	RANDOLPH
MO2010538	MONROE CITY PWS	SOUTH LAKE #1	MONROE
MO2010538	MONROE CITY PWS	ROUTE J LAKE #1	MONROE
MO5010560	NEOSHO PWS	SHOAL CREEK	NEWTON
MO2021537	NORTH CENTRAL MO REGIONAL WATER COM	LOCUST CREEK	SULLIVAN
MO2021537	NORTH CENTRAL MO REGIONAL WATER COM	GOLF COURSE SOUTH LAKE	SULLIVAN
MO2021537	NORTH CENTRAL MO REGIONAL WATER COM	ELMWOOD LAKE	SULLIVAN
MO2010623	PALMYRA PWS	NORTH RIVER	MARION

Public Water System Surface Water Sources

PWS ID	System Name	Stream Name	County
MO4010636	PERRYVILLE PWS	SALINE RIVER	PERRY
MO4010640	PIEDMONT PWS	BLACK RIVER	WAYNE
MO1010648	PLATTSBURG PWS	SMITHVILLE RESERVOIR	CLINTON
MO4010656	POPLAR BLUFF PWS	BLACK RIVER	BUTLER
MO1010682	RICH HILL PWS	RICH HILL RESERVOIR	BATES
MO1010682	RICH HILL PWS	BATES CO DITCH	BATES
MO4240120	S F SCOUT RANCH	LAKE NIMS	ST FRANCOIS
MO4240120	S F SCOUT RANCH	LAKE NIMS #2	ST FRANCOIS
MO2010736	SHELBINA PWS	SALT RIVER	SHELBY
MO2010736	SHELBINA PWS	SHELBINA LAKE	SHELBY
MO2181076	SMITHFIELD FARMLAND CORP	ELMWOOD LAKE	SULLIVAN
MO1010748	SMITHVILLE PWS	SMITHVILLE CITY	CLAY
MO1010748	SMITHVILLE PWS	SMITHVILLE RESERVOIR	CLAY
MO5010754	SPRINGFIELD PWS	JAMES RIVER	GREENE
MO5010754	SPRINGFIELD PWS	MCDANIEL LAKE	GREENE
MO5010754	SPRINGFIELD PWS	FELLOWS LAKE	GREENE
MO5010754	SPRINGFIELD PWS	STOCKTON LAKE	GREENE
MO2010796	TRENTON MUNICIPAL UTILITIES	THOMPSON RIVER	GRUNDY
MO2010804	UNIONVILLE PWS	LAKE THUNDERHEAD	PUTNAM
MO2010804	UNIONVILLE PWS	UNIONVILLE LAKE (LAKE MAHONEY)	PUTNAM
MO1010921	UNITY VILLAGE	UNITY VILLAGE LAKE 1	JACKSON
MO1010921	UNITY VILLAGE	UNITY VILLAGE LAKE 2	JACKSON
MO2010812	VANDALIA PWS	VANDALIA LAKE	AUDRAIN

VII. CHEMICAL ANALYSES OF COMMUNITY WATER SYSTEMS

CHEMICAL ANALYSES OF COMMUNITY WATER SYSTEMS
INTRODUCTION
KEY TO CODES

The Chemical Analyses of Community Water Systems section contains data on inorganic chemical test results. Under Missouri's Public Drinking Water Regulations (10 CSR 60-4), systems utilizing surface water sources in whole or in any part are required to submit water samples every year for chemical analyses. Those systems utilizing only groundwater sources are required to submit water samples for nitrates every year and inorganic chemical samples once every three years. These analyses are performed by the Missouri Department of Natural Resources' laboratory. Results are given in this section for a group of common inorganic chemicals that each community system tests for, and the value provided represents the most recent sample for the chemical. If no result is listed, the water system has never been sampled for the specified chemical. This may be because the water system is newly activated, or the water system has recently been reclassified as a community water system.

Below is a list of chemicals included in this section. In parentheses behind some of the chemicals are suggested upper limits or regulatory maximums given in milligrams per liter. In addition to the below named chemicals, analyses was also completed for the following inorganic chemicals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and thallium. The complete results of all of the chemical analyses are on file in the office of the Missouri Department of Natural Resources' Public Drinking Water Branch, and can be viewed at dnr.mo.gov/DWW/.

AL – Aluminum (200.0–500.0)	ALK – Alkalinity, Total as CaCO3
CA – Calcium	CL – Chloride (250.0)
CU – Copper (1000.0)	F – Fluoride (2.0)
FE – Iron (300.0)	K – Potassium
MG – Magnesium	MN – Manganese (50.0)
NA – Sodium	NO3 – Nitrate (10.0)
PH – pH	SO4 - Sulfate (250.0)
TDS – Total Dissolved Solids (Total Filterable Residue) (500.0)	TH – Total Hardness

In the following results, chemicals are listed in terms of either milligrams per liter (parts per million), micrograms per liter (parts per billion), or, in the case of PH, pH units. The chemicals are measured as follows:

Milligrams per Liter (mg/L)		**Micrograms per Liter (ug/L)**
ALK – Alkalinity, Total	NA - Sodium	AL - Aluminum
CA – Calcium	NO3 - Nitrate	CU - Copper
CL - Chloride	SO4 - Sulfate	FE - Iron
F - Fluoride	TDS – Total Dissolved Solids	MN - Manganese
K - Potassium	TH – Total Hardness	
MG - Magnesium		

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
10 4 WATER SYSTEM	370	73.9	5.04	0	0	47.3	3.92	0.11	7.42	7.12	351	323	13.6	8.88	0	0
5 81 MOTEL & CAMPGROUND	342	60	0	0	0	37.1	3.07	0.38	7.6	6.09	366	323	0	2.12	38.2	0
A&H COUNTRY ESTATES	283	72.8	0	0.19	1.43	29.1	3.35	0.08	7.42	18.1	297	302	0	2.29	9.91	3.24
ACRES OF SHADE MHP	199	48	0	0.12	2	22.5	3.46	0	7.81	30.5	229	213	0	0	78.7	1.82
ADRIAN PWS	143	56.3	46.6	0.14	4.37	11.3	27.9	0.046	7.43	80.1	308	187	54.1	8.25	0	10.9
ADVANCE PWS	175	60.1	15.2	0.24	1.59	16.3	10.7	0.014	7.23	39.9	298	217	0	2740	248	41.4
AGAPE BOARDING SCHOOL	180	37.4	46.1	0.44	5.03	19.2	30.6	0.028	7.71	19.2	277	172	0	27.1	0	0
AIRPORT HOMEOWNERS ASSN IN	292	59.5	0	0	1.21	34.2	1.87	0.17	7.74	14.7	274	289	0	13.9	0	0
ALBA PWS	189	51.6	9.24	0.27	2.11	18.7	8.71	0	7.74	24.5	237	206	0	0	107	2.49
ALBANY PWS	282	96.6	37.1	0.76	1.61	19.4	34.2	0.31	7.65	108	507	321	0	8.64	0	0
ALLEN ACRES	334	60.6	58.2	1.75	7.77	30.9	71.9	0.02	7.68	69.4	476	279	0	11.6	0	0
ALTA VISTA MOBILE VILLA	273	64.4	6.52	0	1.17	36.5	3.67	1.21	7.61	15.1	305	311	0	19.1	0	0
ALTENBURG PWS	346	86.9	5.22	0.24	1.18	31	6.44	0	7.31	31	345	345	0	108	85.4	2.48
ALTON PWS	2890	55.8	64.6	0	1.48	34.2	50.9	0.081	8.03	6.81	382	280	0	4.48	18.7	0
ANDERSON PWS	134	23.4	15.1	0.84	2.11	10.5	20.7	0	7.69	19	142	102	0	1.93	0	0
ANNAPOLIS PWS	303	29.4	20.8	0.28	1.2	23.6	17.9	0.17	8.13	11.5	216	171	0	1.63	0	0
ANTHONIES MILL RESORT SUBDI	349	66.2	0	0	0	41.9	3.3	0.41	7.39	9.81	332	338	0	3	0	0
ANTIRE VALLEY SUBD	237	83.4	20.9	0.25	3.12	12.4	9.75	0.7	7.3	25.9	311	259	0	8.35	13.6	0
APPLE VALLEY COURT	185	44.5	0	0	1.58	20.6	1.84	0	7.93	13.2	197	196	0	14.1	16.8	0
ARBYRD PWS	355	2.8	52.3	0.4	2.55	0	219	0	8.63	14.2	495	9.05	0	28.1	40.4	2.81
ARCADIA PWS	245	51.1	10	0.1	1.81	29.3	8.98	0.28	7.35	23.9	253	248	0	66.9	10.2	3.94
ARCHIE PWS	167	47.1	43.8	0.15	4.09	11.3	29	0.05	7.5	69.3	272	164	37.6	35.2	0	0
ARCOLA PWS	145	32.5	9.72	0.37	2.53	15.6	12.7	0.019	7.96	16.8	179	145	0	3.4	49.5	0
ARGYLE ESTATES WATER SUPPL	239	47.3	0	0	0	28.7	2.8	1.16	7.63	6.58	243	236	0	2.37	33.9	0
ARROW POINT VILLAGE PWS	274	56	0	0	1.3	30.6	2.62	0	7.5	14.7	265	266	0	2.47	15.4	1.25
ARROW RIDGE SHORES	282	59.9	0	0	0.9	34.5	1.8	0	7.29	8.84	264	292	0	125	132	2.27
ASBURY PWS	165	49.8	0	0.54	2.92	19.1	8.53	0	7.81	40.3	218	203	0	7.97	144	2.25
ASH GROVE PWS	145	35.6	0	0.14	1.33	16.9	3.81	0.012	7.87	19.2	178	158	0	0	37.1	1.11
ASHLAND PWS	350	71.4	5.6	0.78	1.71	37.7	14	0	7.34	20.2	323	334	0	4.98	61.5	2.39
ATCHISON COUNT WHOLESALE	172	28	17.6	0.14	3.43	6.77	16.7	0.017	7.88	42.3	177	97.8	12.2	9.46	0	0
AURORA VERONA	192	48.4	5.14	0	1.04	22.1	2.23	0.1	7.78	13.8	202	212	0	3.19	0	0
AUXVASSE PWS	321	68.5	10.3	0.9	3.22	27.5	23.4	0	7.66	14.8	359	261	0	23.9	171	5.5
AVA PWS	240	56.4	13.8	0	2.27	31.9	3.12	0.35	7.58	27.9	296	272	10.5	3.02	26.7	0

Inorganic Chemical Analyses

	mg/L (parts per million)												ug/L (parts per billion)			
SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
AVERY MOBILE HOME COURT	306	66.6	10.5	0.12	2.52	36.7	8.54	0.37	7.44	35.9	341	317	0	1.83	327	0
BAISCH NURSING CENTER	255	51.4	0	0	0	30.3	1.91	0	7.64	16.7	246	253	0	6.62	16.3	1.02
BAKERSFIELD PWS	346	68.7	0	0	1.08	40.6	1.54	0.73	7.46	10.5	335	339	0	53.1	0	0
BALD EAGLE WELL LLC	190	49	0	0.14	1.72	22.2	0	0	7.85	14.3	153	214	0	3.3	42.4	5.26
BAPTIST HOME	253	54.8	34.4	2.07	1.42	32.3	42.7	0.87	7.67	50.8	378	270	0	96.3	39.8	12.2
BARNETT PWS	254	56.9	0	0	0.99	31.5	5.61	0.028	7.66	31.3	260	272	0	18.9	17	2.19
BARRY COUNTY PWSD 2	298	59.2	0	0	1.73	32.5	1.85	0	7.75	16.6	286	282	0	4.51	89.3	2.3
BARTON DADE CEDAR JASP COU	171	44.4	81.4	0.25	2.16	21.1	10.5	0	7.76	10.1	344	159	0	23.8	64.3	0
BATES COUNTY PWSD 2	146	54.9	17.6	0.11	3.18	9.19	20.2	0.014	7.54	77.4	259	175	97.4	5.91	0	0
BEACH CLUB CONDO ASSN	340	71.9	0	0	0.58	43.4	3.4	0.2	7.48	18.4	332	358	0	179	0	0
BELL CITY PWS	275	57.9	0	0.16	1.3	28.1	6.17	0	7.66	10.1	262	260	0	112	97.1	9.12
BELLE PWS	144	31.9	0	0.12	0.82	21	2.02	0	7.94	19.4	164	166	0	15.7	16.6	2.01
BELLEVIEW VALLEY NURSING H	293	0	6.65	1.65	0	0	178	0	7.59	91.3	438	0	0	17.6	17	0
BELLFLOWER PWS	413	66.6	18.1	1.32	8.54	33.8	58.9	0	7.33	53.3	503	305	0	83	116	2.31
BENDCO COVE	355	76.1	0	0	0	45.5	2.75	0.15	7.4	7.45	332	392	0	32.6	0	0
BENNINGTON ESTATES	321	57.3	97.4	2.42	12.1	28	91.7	0	7.51	114	628	258	0	5.58	42.4	1.37
BENTON PWS	273	64.1	10.7	0.13	1.17	29.9	13.8	2.2	7.63	17.9	314	283	0	9.96	0	0
BERGER PWS	250	49.6	0	0.17	1.83	33	5.18	0	7.5	19.5	259	260	0	0	36.1	1.05
BERNIE PWS	147	45	10.7	0.71	1.75	9.35	7.41	0.016	7.55	21.3	203	151	0	147	136	13.6
BERTRAND PWS	206	46.6	11.8	0	1.07	8.99	5.99	0	7.68	29.7	198	153	0	4.97	10.6	1.67
BETHANY PWS	99.2	31.5	13.6	0.61	4.15	5.13	22.1	0.054	7.64	54.4	203	99.8	521	5.07	0	5.66
BIG COUNTRY ACRES SUBDIVISI	327	62.7	33.2	1.57	8.47	30.3	47	0	7.51	60	425	281	0	2	370	5.1
BIG ISLAND WATER COMPANY	192	51.8	48.3	0.34	3.63	23.3	23.3	0	7.9	14.8	301	225	0	2.22	106	4.87
BIG RIVER HILLS LLC	302	59.4	0	0	1.52	42.6	5.64	0.094	7.61	28.3	328	324	0	10.8	0	0
BIG VALLEY COURT	255	12.7	5.38	2.3	7.92	7.54	99.8	0.12	7.58	19.9	280	10.9	0	5.12	21.8	0
BIG VALLEY PARK MHP	250	42.1	0	0.73	1.69	13.9	20.9	0.045	7.83	16.9	184	162	0	1.38	0	0
BILLINGS PWS	188	41.6	0	0	1.35	24.6	2.48	0	7.78	12.4	201	205	0	46.4	0	0
BILYEU RIDGE WATER COMPAN	141	33.2	0	0.22	1.8	16.3	2.09	0	8.05	15.8	158	150	0	0	13.3	0
BIRCH TREE PWS	197	37.9	0	0	0.6	21	1.35	1.1	7.45	0	175	159	129	40.2	43.6	0
BISMARCK PWS	308	88.9	12.9	0	3.29	54.2	20.6	0.97	7.35	117	514	445	0	67.6	11.5	0
BLACK FOREST HOA INC NO 2	269	47.9	0	0.16	1.88	30.6	3.87	0	7.7	14.1	226	246	0	11.3	18.3	0
BLACKHAWK ESTATES	310	74.2	6.85	0	0.93	45.3	2.6	0.37	7.59	7.91	338	372	0	213	0	0
BLAIRSTOWN PWS	210	37.8	110	1.56	7.34	6.98	103	0.52	7.86	65.9	499	123	17.5	4.95	21.8	1.52

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
BLAND PWS	263	59.8	0	0	1.33	39.6	3.3	0	7.9	56.1	311	312	0	56.3	119	2.48
BLOCK SIX WATER ASSN	270	75.2	13.4	0.13	3.46	36.9	9.54	0.38	7.34	98.3	400	340	0	2.35	13.1	0
BLODGETT PWS	193	44.9	17.1	0	1.13	7.79	10.4	0	7.79	5.14	188	144	0	11.7	5.86	1.08
BLOOMFIELD PWS	75.6	22.3	6.91	0	0.94	7.8	13.7	0	6.28	35.2	154	87.8	0	43.6	477	253
BLOOMSDALE PWS	250	58.6	10.2	0.14	1.31	33.4	6.1	0.66	7.84	21.6	301	284	0	113	0	0
BLUE ANCHOR BAY CONDOMINI	339	74.8	0	0	0.66	44.3	2.79	0	7.8	12.9	343	369	0	18.1	82	2.37
BLUE BRANCH IMPROVEMENT A	271	74.3	0	0.15	1.71	35.7	1.79	0	7.56	42.1	324	332	0	47.8	404	6.16
BLUE RIDGE ESTATES SUBD								0.17								
BLUE STEM ESTATES SUBD	199	48.3	5.05	0	1.83	22	1.66	0	7.57	20.8	232	211	0	1.1	15.6	1.37
BLUE WATER VILLAGE/ BLAKEW	221	49.6	0	0.18	2.03	22.6	1.34	0.015	7.79	18.9	239	217	0	7.66	65.7	5.02
BOHANNA HEIGHTS SUBDIVISIO	243	45.6	0	0.31	2.38	24.3	2.38	0	7.58	22.7	260	214	0	44.1	12	1.92
BOLCKOW PWS	258	78.2	44.6	0.29	2.02	14.9	44.5	0.011	7.64	53.3	396	257	48.1	13.2	168	26.5
BOLIVAR PWS	222	46.1	0	0	1.04	29.3	2.19	0.021	7.71	5.28	186	218	20.1	10.7	32.6	2.93
BOLIVAR SOUTHTOWN UTILITIES	302	78.7	0	0.13	1.57	43.1	5.54	0	7.26	138	476	383	0	2.65	918	9.29
BOLLINGER COUNTY PWSD 1	234	53.1	10.6	0	0.72	28.9	2.98	1.84	7.77	8.11	250	252	38.2	20.2	39.7	0
BONNE TERRE PRISON	270	55.8	0	0.11	1.12	30.5	3.98	0.52	7.59	17.6	295	265	0	208	39.3	3.77
BONNE TERRE PWS	395	65.2	5.79	0	1.41	43.2	3.58	0.36	7.48	55.8	375	341	0	58.4	12	2.88
BOONE COUNTY CONS PWSD 1	280	63.4	5.12	0.62	2.73	29.4	15.3	0	7.63	54.7	470	251	0	98.1	61.7	2.4
BOONE COUNTY PWSD 10	324	63.6	46.7	1.6	9.19	31.8	57	0	7.26	45.9	456	298	0	162	35.3	2.25
BOONE COUNTY PWSD 4	437	66.6	30.3	1.67	4	32.9	74.6	0	7.42	40.3	446	307	0	37.4	32.2	2.79
BOONE COUNTY PWSD 9	295	62.6	84.1	0.65	5.24	29.3	27	0	7.37	19.4	301	278	0	142	8.11	2.22
BOONVILLE PWS	190	64.8	44.8	0.57	8.45	22.1	60.5	2.67	8.03	149	501	253	11.7	5.18	0	1.34
BOSWORTH PWS	222	61.6	40.9	0.26	0	12	45.7	8.05	7.46	40.8	377	203	0	3.04	0	0
BOURBEUSE MHP	300	61.5	8.88	0	0	36.8	6.54	0.28	7.58	16.7	308	305	0	3.16	54.6	1.05
BOURBON PWS	155	41.1	0	0	0.95	18.4	3.99	0.96	7.75	0	201	152	61.9	64.7	0	21.3
BOWLING GREEN PWS	37.8	33.3	10	0	3.08	4.25	3.09	0.17	7.56	58.4	133	101	524	13.8	0	4.05
BRANSON CREEK DEVELOPMEN	282	56	0	0	1.04	27.8	2.35	0.029	7.8	12.7	258	254	0	9.15	0	0
BRANSON PWS	305	51.7	0	0.63	0	28.5	1.32	0.026	7.42	13.1	257	246	0	8.42	150	1.26
BRANSON VIEW ESTATES	219	43.9	0	0	1.27	24.5	2.74	0	7.69	12.6	202	211	0	4.87	11.6	0
BRANSON WEST PWS	189	37.5	0	0	1.14	19.9	2.87	0.017	7.89	13.7	181	176	18.6	56.9	19.2	0
BRAYMER PWS	207	44.8	21.5	0.22	1.57	6.51	24.7	0.072	8.42	14.5	213	139	19.1	1.34	69.8	6.41
BRIAR CLIFF SUBDIVISION	369	73.1	13.1	0	1.81	44.2	5.78	0.26	7.19	21.9	374	417	0	4.07	7.57	0
BRIARWOOD & REDBUD SHORES	310	65.2	0	0	1.34	35.6	2.93	0.017	7.61	16.8	287	309	0	9.47	257	1.53

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
BRIARWOOD UTILITIES	281	65.1	0	0	1.3	34.4	2.45	0	7.51	27.8	302	304	0	1.87	84.9	2.16
BRIDGEPORT 1ST ADDITION	254	69.6	6.8	0	1.93	31.6	2.96	0.38	7.52	50.6	319	301	0	1.8	58.2	1.58
BRONAUGH PWS	849	7.59	107	3.17	8.37	4.04	545	0.028	8.3	0	1090	35.6	0	27.2	49	0
BROOK HILL SUBDIVISION	295	61.3	50.4	1.69	9.98	29.7	75.5	0.018	7.5	70.4	470	275	0	91.8	346	4.59
BROOKFIELD PWS	125	27	12.6	0.87	3.64	5.3	27.7	0.21	7.62	18.6	160	89.2	175	1.42	0	0
BROOKVIEW APARTMENTS	271	55.3	0	0	0.78	31.5	2.77	0.18	7.64	10.8	238	268	0	7.64	5.93	4.96
BUELAH LAND ESTATES	289	49.2	46.2	1.56	0	31.1	190	0	7.54	55.2	445	251	0	10.6	5.28	1.32
BUFFALO PWS	258	50	0	0	0.78	28.7	3.38	0.041	7.68	5.06	216	243	0	9.98	0	0
BULL CREEK VILLAGE	234	47.1	5.32	0	1.2	25.6	2.96	0.014	7.87	17.6	226	223	0	9.73	21	0
BUNCETON PWS	316	69.8	0	0.29	3.05	32.1	7.94	0	7.7	16.7	298	306	0	3.34	149	3.34
BUNKER PWS	180	32.8	0	0	0	22.2	1.1	0.22	7.82	0	184	173	0	7.18	0	0
BURLINGTON JUNCTION PWS	345	75.5	37.6	0.36	1.85	22.6	69.8	0	7.45	66.5	486	282	0	114	0	0
BUTLER COUNTY PWSD 1	238	42.8	9.81	0	0.57	27.1	3.02	0.54	7.68	6.23	237	220	0	0	0	0
BUTLER COUNTY PWSD 2	224	20.5	131	0.49	6.09	5.68	159	0	8.07	15.9	474	74.5	0	1.11	118	6.26
BUTLER COUNTY PWSD 3	227	43.7	14.7	0.27	0.91	20.9	6.07	0	7.5	9.64	240	195	0	2.14	37.4	4.19
BUTLER PWS	54.6	22.1	44.5	0	4.42	3.25	23.3	1.77	7.5	13.3	165	68.6	97.4	1.6	0	0
BUTTERFIELD PWS	152	30.2	0	0	1.09	14.9	2.54	0	7.75	13.7	142	156	0	0	79.4	1.45
BYBEE ESTATES	282	77.4	0	0.29	4.52	43.1	9.42	0	7.2	119	442	371	0	14.8	230	3.94
CABOOL PWS	263	52.7	5.53	0	0.99	32.3	2.25	0.4	7.66	8.6	255	265	0	1.04	9.43	1.67
CALDWELL COUNTY PWSD 1	321	81	32.4	0.28	0	8.37	31.9	0	7.94	18.6	349	237	47.6	0	172	28.5
CALEDONIA PWS	253	48.6	0	0.11	0.66	30.5	3.33	0.63	7.56	10.8	256	247	0	228	124	0
CALIFORNIA PWS	306	62.9	0	0	1.09	27.2	3.84	0	7.59	13.7	295	238	0	48.3	152	2.41
CALLAWAY 2 WATER DISTRICT	387	63.7	18.2	1.26	6.9	28.7	17.6	0	7.33	23.3	353	281	0	126	165	3.27
CALLAWAY COUNTY PWSD 1	320	65.2	7.11	0.68	3.58	27.8	20	0	7.72	28	348	254	0	281	43.2	3.43
CAMDEN COUNTY PWSD # 5 CED	320	72.2	5.99	0	0	43.9	2.32	1.2	7.52	0	368	361	0	138	0	0
CAMDEN COUNTY PWSD # 5 CLE	367	71	0	0	0	44.4	1.98	0.36	7.42	10.1	344	360	0	5.46	0	4.7
CAMDEN COUNTY PWSD #4 SHA	257	56.3	0	0	0.61	31.3	1.95	0	7.58	5.53	236	269	0	81.5	84.6	11
CAMDEN COUNTY PWSD 1	280	61	0	0	0.75	34.3	2.13	0.23	7.9	11.3	257	294	0	11.9	0	0
CAMDEN COUNTY PWSD 2	257	55.1	0	0	0.74	32.1	2.4	0.22	7.56	7.2	239	270	0	106	0	0
CAMDEN COUNTY PWSD 3	389	66.3	0	0	0.71	39.1	4.55	0.011	7.29	0	310	327	0	12.1	0	0
CAMDEN COUNTY PWSD 4 HORS	238	47.5	18.2	0.68	3.16	22.7	23.6	0.035	7.75	22.6	245	212	0	225	21.1	2.1
CAMDEN PLACE APARTMENTS	389	78	8.09	0	0.71	49.5	3.64	0.3	7.27	0	394	399	0	25.5	0	0
CAMDENTON PWS	304	57.7	0	0	0.77	36.8	2.65	0.72	7.67	0	310	275	0	54.4	0	0

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
CAMELOT ESTATES MHP	195	44.6	16.5	0	0.78	24.9	6.27	0.92	7.55	0	216	214	0	25.4	0	0
CAMERON PWS	135	41.8	27.8	0.68	5.36	7.54	17.7	0.54	7.71	19.7	206	135	136	62.2	0	0
CAMPBELL PWS	240	6.37	68.7	0.31	3.81	1.54	155	0	8.36	10.9	384	22.2	0	26.1	30	3.21
CANTON PWS	42.8	10.3	40.3	0.53	3.14	13.3	10.1	0.17	7.87	8.72	136	80.5	0	11.6	0	0
CANYON FOREST EAST AND WES	166	20.6	0	0.2	1.51	11.1	36.7	0	7.76	17.3	188	97.1	0	5.98	0	2.87
CAPE FAIR ESTATES	350	65.4	6.83	0	1.51	33.5	2.6	0.013	7.22	13.1	322	325	0	3.03	11.2	0
CAPE GIRARDEAU COUNTY PWS	215	43	5.63	0.12	0.78	23.6	4.31	0.18	7.86	9.35	194	191	21.3	10.3	28.2	0
CAPE GIRARDEAU COUNTY PWS	213	44	22.1	0.11	1.39	27.8	10.4	0.094	7.78	9.23	253	225	0	37	1360	32
CAPE GIRARDEAU COUNTY PWS	275	46.4	98.2	1.74	7.64	23.6	74.8	0.11	7.76	120	545	213	0	30.9	18	3.17
CAPE GIRARDEAU PWS	87.3	76.6	27.1	0.19	2.17	11.2	22.6	0.033	7.36	46.9	356	115	0	0	0	0
CAPE PERRY COUNTY PWSD 1 SO	270	68.2	0	0.6	2.07	30.6	6.69	0.1	7.62	11.1	283	292	0	96.9	0	0
CAPS COVE SUBD	259	52.9	11.2	0	1.77	30.1	4.58	0	7.43	14	268	256	0	16.4	25.1	2.68
CARDWELL PWS	336	2.84	62	0.41	2.64	0.54	215	0.043	8.59	13	489	9.32	0	8.39	44.4	2.93
CARL JUNCTION PWS	165	54.1	8.86	0.37	1.89	24	21.5	0	7.78	28.8	207	225	0	16.6	36.4	4.86
CAROLINA OAKS PLANTATION	233	47.2	0	0.38	3.24	23.8	4.01	0	7.89	29.9	209	216	0	6.1	391	5.23
CARROLL COUNTY PWSD 1	164	17	18.8	0.16	4	18.1	20	0.019	7.98	16.9	188	117	0	8.04	18.3	0
CARROLLTON PWS	130	22.5	17.1	0.74	3.65	11.4	9.13	0.03	7.69	40.9	170	103	0	0	0	0
CARTER COUNTY PWSD 1	382	53.6	7.85	0.11	0	33.1	3.95	0.31	7.87	0	268	270	0	48.3	0	0
CARTER COUNTY PWSD 2	649	51.7	16.1	0	0.6	28.8	4.95	1.69	7.86	0	259	248	0	13.2	6.65	0
CARTERVILLE PWS	205	49.1	0	0.14	1.99	18.6	5.16	0	7.89	18.9	212	199	0	21.4	0	0
CARTHAGE PWS	136	43	32.6	0.5	1.37	17.9	7.27	0.18	7.71	28	188	167	0	2.96	402	0
CARUTHERSVILLE PWS	79.2	6.41	0	0.13	5	2.4	33.9	0.01	7.45	13.6	129	25.9	0	54.8	160	10.5
CASS COUNTY PWSD 7	134	62.5	37.5	0.11	4.05	10.7	50.4	0.053	7.89	171	429	200	76.7	67.8	0	4.9
CASSVILLE PWS	166	36.2	0	0	1.64	17.7	2.1	0	7.8	13.2	168	163	0	40.7	104	1.61
CATAMOUNT RIDGE PROPERTY	262	64.2	0	0	1.13	27.5	2.08	0.021	7.61	19.9	269	274	0	15	0	0
CEDAR COUNTY PWSD 1	163	41.4	123	0.3	4.44	18.2	73.8	0	7.91	15.7	391	178	0	2.19	449	7.54
CEDAR COVE PARK SUBD	223	119	7.87	0	1.92	52	2.87	0	7.47	264	620	511	0	22.1	254	3.28
CEDAR GLEN CONDOMINIUMS	317	65.1	0	0	0.7	39.8	1.8	0.57	7.23	0	300	326	0	6.18	0	0
CEDAR GREEN LAND ACQUISITIO	294	53	0	0.55	0	31.9	1.92	0.74	7.56	6.77	289	264	0	5.59	0	0
CEDAR GROVE VILLAGE SUBD	386	93.8	0	0.83	5.25	60.4	15.5	0.47	7.1	174	591	483	0	3.25	10.7	5.47
CEDAR HILL APTS	237	43.6	0	0	1.63	21.1	2.54	0	7.77	11.8	193	196	71.1	18.7	88.5	1.69
CEDAR HILL ESTATES WATER	280	59.8	5.56	0.13	2.17	31.9	6.06	0.013	7.61	21.5	281	281	0	2.06	14.8	2.41
CEDAR HILL LAKES VILLAGE	296	64.3	0	0	1.46	36.9	3.48	0.054	7.72	21.4	305	313	0	2.48	14.7	0

Inorganic Chemical Analyses

SUPPLYNAME	mg/L (parts per million) Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	ug/L (parts per billion) Al	Cu	Fe	Mn
CEDAR KNOLL HOME	259	57.3	0	0	0.86	32.7	2.82	0	7.44	22.4	280	278	0	9.27	11.5	2.12
CEDAR SHORES RANCH ESTATES	321	62.8	0	0	1.05	37.5	1.45	0.3	7.3	5.33	307	311	0	2.03	23.1	1.28
CEDAR SPRINGS MHP INC	182	44.6	0	0	1.9	24.7	1.39	0	7.67	25.9	208	213	0	3.13	271	1.82
CEDARIDGE ESTATES	181	40.8	0	0	0	20.9	1.6	0.27	7.87	14.7	200	188	0	35.6	622	0
CENTERTOWN PWS	344	67.2	0	0.15	0.82	35	5.23	0	7.51	13.5	313	312	0	105	124	7.7
CENTERVILLE PWS	266	57.8	7.37	0	1.43	33.9	5.98	0.81	7.52	8.36	266	284	0	10.4	0	0
CENTRAL CROSSING ACRES II	283	74	29.8	0	1.57	41.9	13.3	0.054	7.47	16.1	384	357	0	27.9	0	0
CENTRAL MO CRRCTNL CTR	294	60.8	15.1	0.68	3.75	28.5	27.4	0	7.56	20	329	269	0	122	40.5	0
CENTRALIA PWS	211	17.7	61.3	1.2	11.3	28.6	70.8	0.12	8.63	78.8	381	162	0	34.1	32.2	0
CHAFFEE PWS	299	88.3	86.3	0.21	2.58	38.8	45.4	0.16	7.14	83	618	380	0	127	88.7	3.95
CHAIN O LAKES VILLAGE PWS	247	56.8	0	0	0	26.4	1.45	0.013	7.68	11	249	251	0	13.5	29.4	1.47
CHAMOIS PWS	321	59.7	0	0.15	1.3	34.7	5.42	0	7.4	17.3	273	292	0	4.19	348	6.11
CHAMPION FARMS SUBDIVISION	437	34.7	262	3.94	11.7	17.4	404	0	7.96	239	1080	164	0	12.1	14	1.52
CHAPEL HILL SUBD	261	64.1	0	0.21	3.42	32.3	6.05	0	7.43	80.8	351	293	0	11.5	17.2	0
CHARLESTON PWS	156	29.9	0	0.72	1.14	7.1	6.19	0	7.67	0	130	104	0	1.8	7.06	0
CHELSEA ROSE SUBD	314	79.2	60.7	0.18	2.16	40.8	25.6	0.063	7.44	9.88	383	366	0	70.3	25.4	2.22
CHILLICOTHE MUNICIPAL UTILIT	136	17.9	17.9	0.7	1.88	12.7	13.8	0.036	7.8	28.4	165	97	30.4	5.89	19.1	2.2
CHRISTIAN ASSOCIATES OF TABL	237	48.7	0	0	1.17	24.8	1.83	0.051	7.73	18.4	244	224	0	2.61	6.66	0
CHRISTIAN COUNTY PWSD 1	170	37.4	0	0	1.38	20	1.79	0	7.83	16.4	179	176	0	8.84	54.9	0
CIMARRON BAY SUBDIVISION	294	72.7	0	0	0.94	40.7	3.72	0	7.45	15.5	328	349	0	158	249	2.59
CIRCLE C MOBILE HOME PARK	321	70.3	20.9	0.12	1.76	39.5	14	0.35	7.72	39.7	363	338	0	3.98	0	0
CITYDEL MHP	180	42	7.7	0	1.17	22.5	1.65	0.21	7.9	12	201	198	0	5.24	69.1	0
CLARENCE CANNON WHOLESAL	99.1	55	62	0.18	6.73	4.55	13.1	0.63	7.67	12.5	257	156	0	11.2	0	0
CLARK COUNTY CONS PWSD 1	225	66.2	11.6	0	1.41	15.1	5.98	4.9	7.43	33.5	271	227	0	592	0	0
CLARKSBURG PWS	712	71.1	22.2	0.3	1.82	32.8	21.8	0	7.74	15.4	368	313	0	5.23	34.7	3.31
CLARKSVILLE PWS	337	31.3	255	1.24	13	15.7	297	0.024	7.7	92	928	143	0	18.1	0	0
CLARKTON PWS	244	7.3	53.1	0.25	3.82	1.54	142	0.17	8.44	10.7	358	24.6	0	21.7	28	4.59
CLAY COUNTY PWSD 3	107	15.8	22.9	0.2	1.46	12.8	12.4	0.06	8.66	39.9	173	92.2	0	0	0	0
CLEAR COVE LANDING	202	42.3	0	0	0	21.1	2.47	0	7.84	11.8	194	193	0	3.38	122	1.93
CLEAR WATER ACRES SUBD	249	50.2	10	0	1.42	25.6	4.91	0.17	7.7	15.8	236	233	0	6.22	0	0
CLETS TRAILER PARK	244	52.5	5.48	0	0.68	29.5	3.15	0.26	7.6	0	231	253	0	1.8	8.08	0
CLEVENGER BRANCH MEMBERS	266	62.8	0	0	1.47	29.8	1.03	0.026	7.6	10.6	268	280	0	4.11	26.7	1.06
CLEVER PWS	136	32.5	0	0	1.53	15.5	2.06	0	7.99	14.1	140	140	0	14.8	492	27.1

Inorganic Chemical Analyses

	mg/L (parts per million)												ug/L (parts per billion)			
SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
COACHLIGHT VILLAGE MHP	285	59.2	5.99	0	1.54	34.4	2.08	0.034	7.4	21.5	301	289	0	25.8	177	41.1
COLE CAMP PWS	248	56.9	0	0	0	33.4	3.33	0	7.74	37.4	263	280	0	0	421	5.4
COLE COUNTY PWSD 1	305	58.8	0	0.59	1.06	36.3	3.13	0	7.48	26.9	308	277	0	72.7	44	3.09
COLE COUNTY PWSD 2	334	79.6	0	0.55	1.21	43.3	7	0	7.48	20.8	400	252	0	120	40.9	4.97
COLE COUNTY PWSD 3	321	64.6	0	0.24	1.64	36	4.71	0	7.68	34.9	313	304	0	112	19.2	1.29
COLE COUNTY PWSD 4	311	64.1	0	0.49	1.42	30	5.72	0	7.54	13.5	277	290	0	160	371	11.9
COLE COUNTY PWSD 5	337	73.1	0	0	0.84	41.1	2.58	0	7.37	21.6	342	352	0	145	75.8	1.97
COLE TURKEY ACRES	330	77.3	0	0	0.87	45	14.9	1.03	7.34	15.4	292	370	0	2.53	11.5	1.94
COLLEGE OF THE OZARKS	272	31.7	6.14	0	1.12	27.2	3.97	0	7.57	15.8	227	238	0	391	24.6	1.55
COLLINS PWS	239	51.3	6.4	0.3	3.82	22.5	9.03	0	7.57	40	260	221	0	24.4	167	2.2
COLONY COVE MHP	345	73.7	8.37	0	1.66	43.4	2.97	0.076	7.51	20.4	343	363	0	0	0	71.7
COLUMBIA PWS	121	35.3	36.4	0.55	5.14	19.9	36.9	0.021	8.55	84.6	292	170	0	1.56	105	3.43
COMMUNITY WATER SYSTEM	218	45.7	0	0	0	26	2.32	0.087	7.71	0	223	221	0	2.75	7.2	0
CONCEPTION JUNCTION PWS	176	74.6	28.3	0.14	1.3	17.1	33.7	0.66	7.48	112	413	257	51.8	2.85	301	21.2
CONCORDIA PWS	90.5	25.9	11.7	0.21	4.33	4.85	5.07	0.69	7.22	12.4	123	84.6	119	2.37	0	3.52
CONWAY PWS	235	52.5	0	0	0.82	29.5	3.14	1.35	7.9	0	239	253	0	12.5	15.6	0
COOPER COUNTY CONSOLIDATE	313	64.1	8.01	0.66	5.07	30.1	15	0	7.34	27.1	330	284	0	216	88.8	2.54
COOPER COUNTY PWSD 1	257	63.1	186	0.78	5.57	28.9	113	0.01	7.53	44.6	563	275	0	119	98.5	3.14
CORNER WATER COMPANY	296	55.4	0	0	0.55	31	3.52	0.17	7.47	0	269	266	0	7.13	0	0
COUNTRY ACRES MOBILE HOME	264	0	0	0.48	0	0	161	0	7.74	68.2	391	0	0	3.41	15.3	0
COUNTRY ACRES SUBD	257	53.9	5.78	0.66	4	25.7	20.5	0.014	7.41	48.3	302	240	0	20.9	26.1	1.68
COUNTRY AIRE APARTMENTS	151	32.7	0	0	0.95	13.8	1.89	0.44	7.85	6.36	139	138	59.3	362	35.7	0
COUNTRY AIRE ESTATES	253	50.7	0	0	0	30.1	1.48	0	7.55	16.8	253	251	0	1.72	77.9	1.61
COUNTRY AIRE MHP	235	48.5	0	0	1.23	28.2	1.55	0.11	7.72	0	214	237	0	100	0	0
COUNTRY COVE	340	62.5	13.4	0.89	7.13	34.6	41.9	0.053	7.65	83.1	443	299	0	2.26	83	6.27
COUNTRY ESTATES	327	65.6	25.4	1.24	8.17	31	38.1	0.075	7.49	51	406	291	0	1.7	169	5.84
COUNTRY FARM ESTATES HOA I	184	46.4	0	0	1.13	20.3	1.11	0.026	7.71	18.5	211	199	0	3.26	5.83	0
COUNTRY LAKES RV PARK	379	85.1	0	0	1.77	50.9	4.34	0	7.2	29.8	413	422	0	5.97	5	3.48
COUNTRY MEADOWS ESTATES	257	54	0	0	1.49	24.7	2.73	0.35	7.76	10.5	221	237	0	30.9	0	0
COUNTRY SQUIRE VILLAGE	164	40	0	0	1.22	20.1	1.96	0.31	7.73	15.8	183	183	0	0	0	0
COUNTRY TIME ESTATES	190	47.9	0	0	1.24	25.1	1.97	0	7.82	24.6	216	223	0	4.01	31.8	27
COUNTRY VILLAGE ESTATES SU	300	91.5	13.7	0.15	0.59	11.2	12.3	2.12	7.35	6.78	321	275	136	15.1	218	8.93
CRAIG PWS	384	76.1	37.7	0.38	3.76	42	35.8	0	7.94	31.7	464	363	0	456	16.3	1.58

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
CRANE PWS	164	40.9	0	0	1.48	18.7	3.12	0	7.99	20.2	187	194	0	33.9	34.3	0
CRAWFORD COUNTY PWSD 1	215	53.7	15.9	0	0.6	30.4	2.07	0.6	7.58	11.1	238	259	419	50.5	218	9.42
CRESTVIEW ACRES SUBD	283	61	9.43	0	0	33.1	6.3	1.34	7.61	22.5	304	289	0	2.21	0	0
CRESTVIEW MHP	344	71.6	0	0.22	1.97	37.8	16.3	0	7.69	16.6	343	334	19	2.66	130	4.09
CROCKER PWS	269	60.7	0	0	1.32	40.4	1.74	0	7.63	11.7	359	329	35.6	4.54	125	8.7
CROSS CREEK SUBD	341	73.1	0	0	0.84	42.5	1.83	0.027	7.28	8.96	317	358	0	124	91.2	1.78
CROSS ROADS ACRES	160	38.1	0	0	2.21	17.8	2.16	0	7.79	17.2	187	168	0	2.48	84.6	1.27
CROSS TIMBERS PWS	212	48.8	0	0	1.1	24.8	5.65	0.013	7.79	22.5	233	224	0	8.31	26.8	4.04
CRYSTAL BEACH SUBD	304	62	0	0	1.3	35	1.91	0	7.42	14.1	296	299	0	10.2	26.5	0
CRYSTAL CITY PWS	194	28.6	59.9	0.22	4.96	30.7	35.1	0.12	7.8	66.9	321	198	0	53.7	19.7	18.2
CRYSTAL COVE MHP	322	74.5	12.3	0	1.66	46.6	9.66	0.67	7.29	39.8	393	378	0	2.65	8.61	0
CTW WATERWORKS INC	176	36.5	0	0.47	2.07	18	2.62	0	7.86	12.4	168	165	0	9.11	13.4	0
CUBA PWS	226	44.8	0	0.85	0.9	32.4	2.56	0.15	7.83	20.3	273	255	0	63.9	28.2	3.53
DADEVILLE PWS	149	36.9	0	0.14	1.91	17.2	3.33	0	7.87	21.7	174	163	0	13.2	66.2	9.62
DAVIESS COUNTY PWSD 3	115	35.4	20.1	0	2.7	5.63	8.06	0.12	7.2	17	151	112	14	105	0	0
DD16 POA	229	45.2	6.12	0.12	1.61	21.8	1.94	0	7.74	44.9	273	203	0	3.02	334	1.77
DEER MOUNTAIN HEIGHTS	320	71.1	0	0	1.91	38.2	1.54	0.056	7.54	31.6	333	335	0	2.22	54	1.06
DEER RUN APTS	225	47.4	13.1	0	1.79	27.8	2.59	0.12	7.73	17.9	239	233	0	2.33	11.7	1.23
DEER VALLEY SUBDIVISION	288	61.1	63.3	1.2	6.69	30.6	62.2	0.038	7.65	72.1	455	279	0	40.5	678	5.84
DELTA PWS	326	58.2	22.8	0	1.38	31.4	12.5	0.046	7.64	10.9	307	275	0	24.1	20.1	0
DENT COUNTY PWSD 1	216	36.8	0	0	0.7	21.1	3.35	0.14	7.88	0	176	179	0	70.3	0	0
DESLOGE PWS	360	43.5	8.44	0.16	0.98	33.5	6.36	0.96	7.42	21.4	293	247	0	224	0	2.5
DESOTO PWS	346	62.5	10.3	0	0	36.7	6.3	0	7.36	40.4	341	307	0	1.24	67.8	1.63
DEXTER PWS	239	48.8	33.6	0.58	3.8	16.6	29.8	0.023	7.35	14.3	264	190	0	3.59	0	0
DIAMOND PWS	182	41.2	0	0.11	2.12	19.5	4.92	0	7.88	13.4	189	183	0	1270	35.4	1.54
DIANAS BOARDING HOME 2	227	0	0	0	0	0	93.8	0.025	7.74	8.38	223	0	0	7.58	8.43	0
DIGGINS PWS	644	23.9	32.6	0	0.64	12.2	22.4	0	8.26	0	161	110	0	13.8	38.8	8.33
DIXON PWS	256	64	0	0	1.26	36.7	2.15	0.028	7.53	56.2	318	311	0	88	421	5.41
DOCS RETREAT UNIT 1	247	62.6	8.44	0.26	2.68	32.6	9.35	0	7.61	44.3	298	291	0	9.02	470	3.55
DONIPHAN PWS	236	45.2	0	0	0.69	26	2.2	0.29	7.75	8.84	205	220	0	13.7	0	0
DOOLITTLE MHP	274	62.6	0	0	1.31	34.4	1.98	0	7.98	12.2	284	298	0	11.6	175	2.57
DOYLE APARTMENTS	301	66.5	0	0	1.98	34.9	7.79	0	7.88	13.2	315	310	0	154	19.9	0
DUDLEY PWS	240	50.1	30.8	0.22	1.06	17.4	21.1	0	7.85	6.84	271	197	0	136	0	0

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
DUENWEG PWS	167	32.8	0	0.11	1.78	16.1	6.12	0	7.93	16.5	161	148	0	2.87	17.4	1.14
DUNKLIN COUNTY PWSD 1	237	9.2	87.1	0.39	4.15	2.4	146	0	8.27	14	401	38.5	0	5.61	76.3	2.58
DUNKLIN COUNTY PWSD 2	345	1.81	59.3	0.36	1.74	0.55	178	0	8.57	6.38	453	5.26	0	15.9	30.2	2.59
DUNKLIN COUNTY PWSD 3 SOUT	290	4.1	38	0.34	2.32	0	187	0	8.42	9.33	487	13.6	0	9.58	28.4	2.85
EAGLE ESTATES	272	51.4	0	0.28	3.52	30	4.83	0	7.7	24	249	252	0	7.18	76.3	2.94
EAGLE MHP	383	80.9	0	0	0.68	50.4	2.83	0.013	7.56	8.42	387	410	0	10.8	0	0
EAGLE RIDGE ESTATES	268	57.9	10.6	0	1.29	31.1	3.67	0.051	7.61	62.2	313	273	0	14.8	21	0
EAGLE WOODS SUBDIVISION	264	58.1	6.3	0.14	1.06	32.3	2.59	0.027	7.53	12.4	285	278	0	122	90.4	1.09
EAST PRAIRIE PWS	127	32.1	0	0.17	1.11	6.87	4.21	0.051	7.76	0	133	108	0	45.9	19.4	3.79
EAST WIND COMMUNITY	334	65.4	0	0.11	0	40.9	1.4	0.18	7.5	5.97	306	332	0	2	13.6	0
EASTBOUROUGH SUBD	147	36.7	0	0.15	1.11	17.9	1.68	0	7.9	15.1	158	165	0	19.6	134	5.92
ECHO VALLEY SUBDIVISION	363	66.1	0	0	0.77	38.8	3.63	0	7.3	10.2	345	325	0	45.9	6.11	0
ECM WATER & SEWER AUTHORI	353	63.7	40.9	1.36	10.6	29.3	51.2	0.018	7.63	84.5	453	280	0	8.92	28.4	2.12
EDGEWATER VILLAGE	188	43.4	0	0	1.03	22.3	1.31	0.01	7.92	17.8	209	200	0	11.3	0	0
EL DORADO SPRINGS PWS	160	40.2	155	0.43	5.35	18.7	89.3	0	7.84	22.3	410	178	0	1.31	7.51	2.34
EL KAY LAKE VIEW MOTEL	291	64.2	6.72	0	0.76	39	2.56	0.11	7.37	0	301	321	0	6.46	0	0
ELDON PWS	247	54.2	0	0.14	1.23	27.3	5.09	0	7.57	10.7	259	259	0	56.9	12	0
ELLINGTON PWS	184	36.8	0	0	2.36	17.5	2.71	0.36	6.9	8.71	165	164	0	25.1	0	0
ELLSINORE PWS	530	39.5	11.3	0	0.8	25.6	8.53	0.13	8.05	6.73	210	204	0	8.5	0	0
ELM HILLS UTILITY OPERATING	288	61.7	0	0.21	1.56	30.7	8.34	0	7.54	18.3	297	280	0	3.33	86.8	3.43
ELMO SUBDIVISION 1 & 2 & 3	294	61.7	0	0	0	35.2	1.44	0.26	7.46	7.59	275	299	0	3.32	0	0
ELSBERRY HEALTH CARE CENTE	308	52.8	0	0.43	3.93	40.5	8.16	0.038	7.58	31.7	307	299	0	6.54	5.03	16.5
ELSBERRY PWS	171	57.5	63.3	0	1.33	16.8	25.4	0.024	7.52	97.1	365	213	31.4	0	0	21.7
EMERALD BEACH VILLAGE OF P	213	52.9	0	0	1.41	24.1	2.24	0	7.64	11.2	241	243	0	1.08	0	0
EMERALD GREEN ESTATES	316	56	46.6	1.7	8.96	29.5	73	0.044	7.89	71.2	458	261	0	5.34	332	4.8
EMINENCE PWS	309	61.3	7.62	0	1.11	35.5	4.94	0.68	7.4	9.91	319	299	0	3.28	0	0
EMMAUS HOMES INC	383	66.5	9.81	0.27	2.62	32.2	8.28	0.25	7.59	23.1	324	299	0	9.33	19.4	1.83
ESSEX PWS	219	43.1	181	1.24	10.3	12	140	0.012	8.15	18.3	530	157	0	3.93	261	41.8
EUGENE PWS	324	68.9	0	0	1.1	37.5	4.64	0	7.37	23.2	307	326	0	0	250	5.1
EUREKA PWS	316	37	340	0.77	7.7	20	297	0.027	7.28	53.4	879	175	0	43.5	659	26
EVERGREEN LAKE ESTATES	287	51.1	0	0	1.45	31.4	3.89	0.17	7.48	15.8	257	257	0	5.72	6.14	0
EVERTON PWS	145	37.3	0	0	1.45	15.5	2.58	0.12	7.89	13.9	163	157	0	5.89	23.5	0
EXCELSIOR SPRINGS PWS	184	26.9	18.4	0.16	5.09	21.5	7.54	0.04	7.96	32.5	201	156	0	7.63	28	0

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
EXETER PWS	211	43.5	7.36	0	1.32	21.1	4.96	0	7.85	14.5	201	197	0	5.96	64.9	3.44
FAIR HAVEN CHILDRENS HOME	190	64.9	19.2	0.27	3.23	20.4	5.06	0.058	7.69	21.4	273	188	0	38.9	11.1	0
FAIR PLAY PWS	245	54.6	0	0	1.51	31.3	2.06	0.29	7.63	10.5	238	265	0	11.5	11.7	3.13
FAIRVIEW PWS	159	38.8	0	0	1.98	19	3.54	0	7.84	12.4	184	171	0	30	236	6.39
FAIRWAYS WATER AND SEWER	281	55	0	0.11	1.44	32	3.64	0.038	7.46	26.8	290	269	0	37.3	14.2	0
FALL CREEK HEIGHTS SUBD	305	66.3	11.2	0	1.42	39.6	2.32	0.28	7.43	24.4	325	329	0	82.1	0	0
FARMINGTON CORRECTIONAL C	258	53.7	0	0	0.77	33.5	3.39	0.36	7.76	7.88	250	272	0	61.8	0	0
FARMINGTON MANOR	360	3.11	36.3	0.16	0	2.1	181	1.15	7.45	140	616	16.4	0	52	0	0
FARMINGTON PWS	231	54.2	0	0	0	28.3	5.66	0.29	7.69	37.3	282	252	0	0	0	1.56
FARRAR WATER ASSN	383	105	15.5	1.22	1.34	36.4	16.4	1.01	7.58	92.8	496	412	16.1	17.5	16.1	0
FAWN LAKES	325	64.3	0	0.89	6.53	34.6	22.3	0.028	7.45	38.3	364	303	0	12.6	76.6	3.24
FAWN VALLEY ESTATES	326	78.3	0	0	0.94	47.3	1.87	0.072	7.35	10.5	365	390	0	2.89	15.1	0
FERNDALE RESIDENTIAL CARE II	296	79.9	5.28	0	1.45	45.6	6.23	0.023	7.51	97.7	417	387	0	7.96	0	1.01
FERRELLS TRAILER COURT	81.6	27.7	9.04	0	1.32	6.05	6.74	1.09	7.51	13.7	130	94.1	0	4.61	0	43
FICKEN HILL SUBD	303	62.7	0	0	1.54	34.9	2.66	0	7.21	24.1	308	300	0	34.5	0	1.33
FINLEY VALLEY/CITY OF OZARK	152	33.3	0	0.14	1.93	16	40.2	0	7.89	13.3	162	149	0	12.2	421	3.36
FISK PWS	299	61.7	18.3	0.15	1.74	25.9	20.5	0	7.72	27.8	353	261	0	193	256	15.4
FLEMINGTON PWS	248	58.3	0	0	1.86	21.1	4.34	0	7.41	23.9	260	232	0	7.43	549	11.3
FORDLAND PWS	167	43.9	6.75	0	1.08	20.1	1.8	0.32	8	9.16	188	192	20.6	15.8	283	43.5
FOREST GLEN/QUAIL RIDGE SUB	322	71.5	0	0	1.09	37.1	1.45	0.021	7.52	7.23	306	331	0	14.2	17.6	0
FOREST PARK/DEER PARK	260	62.9	0	0	1.18	36.6	1.08	0.051	7.94	7.27	289	308	0	18.3	10.4	0
FOREST RIDGE SUBDIVISION	281	57.4	0	0	0	36.3	2.1	0.23	7.53	0	284	293	0	12.9	107	2.07
FORSYTH PWS	317	59.3	0	0	1.16	27	1.16	0.051	7.52	13.4	276	288	0	145	195	2.27
FORT LEONARD WOOD	255	48.9	0	0	0	25.4	5.9	0.099	7.87	12.7	223	201	0	14.3	15.6	6.13
FOUNTAIN PLAZA MHP	244	51.7	7.59	0.14	1.5	27.2	4.56	0.044	7.73	17.1	269	241	0	2.85	0	0
FOX WOODS SUBDIVISION	338	65.5	15.4	0	5.29	47.8	10.4	0.034	7.49	26.9	400	360	0	61.6	0	0
FOXBORO SUBDIVISION	278	46.7	0	0.1	2.44	34.3	3.08	0.015	7.62	16.1	269	258	0	6.77	276	84.5
FOXHEAD SHORES	311	75	0	0	0.74	45.3	2.63	0.88	7.57	7.17	349	371	0	20.3	0	0
FRANKENSTEIN PWS	261	61.6	0	0.18	1.11	33.9	1.51	0	7.52	29	272	293	0	151	74.3	1.45
FRANKLIN COUNTY PWSD 1	231	44.5	0	0	1.35	26.2	3.69	0.012	7.7	13.6	209	219	0	2.38	0	0
FRANKLIN COUNTY PWSD 1 CAR	252	44.4	0	0	0	28.1	4.91	0.14	7.85	7.32	221	227	0	2.97	22	0
FRANKLIN COUNTY PWSD 3	289	60.5	6.27	0	1.82	34.1	6.81	0.38	7.6	10.1	319	286	0	174	0	0
FRANKLIN COUNTY PWSD 3 LAK	299	58.8	18.8	0.26	0	32.7	18.2	0	7.57	26.1	326	281	0	1.8	26.6	0

Inorganic Chemical Analyses

	mg/L (parts per million)												ug/L (parts per billion)			
SUPPLYNAME	**Alk**	**Ca**	**Cl**	**F**	**K**	**Mg**	**Na**	**NO3**	**pH**	**SO4**	**TDS**	**TH**	**Al**	**Cu**	**Fe**	**Mn**
FRANKLIN COUNTY PWSD 3 ST A	272	61.6	9.08	0	2.14	32.6	8.3	0	7.55	18.2	282	288	0	20.4	237	4.08
FRANKLIN COUNTY PWSD 4	240	49.4	6	0	1.62	34	4.13	0.058	7.57	17.6	256	263	0	3.89	7.82	0
FRANKLIN COUNTY WATER COM	176	37.7	0	0	0	21.4	1.68	0.028	7.73	14.3	190	182	0	0	0	0
FREDERICKTOWN PWS	143	23.8	26.3	0	1.74	14.4	13.2	0.087	7.97	17.4	184	119	96.9	21.5	0	0
FREEBURG PWS	320	57.9	0	0	1.12	40.2	3.23	0.052	7.67	12.6	315	310	0	1.44	14.9	2.32
FREISTATT PWS	134	30.9	0	0.12	1.56	14.9	2.58	0	7.88	16.2	159	139	0	16.9	484	4.34
FRIENDSHIP HILLS SUBD	189	39.6	0	0.16	2.15	22.1	3.49	0	7.71	24.8	207	190	0	1.15	39	0
FROHNA PWS	315	87.1	22.7	0.23	1.56	30.9	11.7	0.014	7.43	29.6	394	345	0	127	79.3	0
FRONTIER ESTATES	234	53.9	56.6	0.59	3.46	31.2	23.8	0.02	7.45	37.5	337	263	0	1.37	24.2	3.61
FUGATE MOBILE HOME PARK	213	47.8	0	0.19	1.88	24.3	3.86	0	7.6	18.2	198	219	0	6	0	1.12
FULTON PWS	354	66.7	19.9	0.93	8.52	30.4	38.2	0	7.3	34.7	403	294	0	4.25	6.67	1.83
GAINESVILLE PWS	373	64.2	6.3	0	1.12	34.7	10.4	0.15	7.52	5.84	279	303	0	3.56	0	0
GALENA PWS	175	34.2	0	0.12	0	20	3.52	0	7.9	11.9	158	164	0	0	661	13.2
GALLATIN PWS	360	137	17.2	0.23	1.25	29.9	19.7	0.078	7.65	70.4	472	465	0	9.96	0	5.61
GARDEN CITY PWS	139	40.5	20.3	0.19	4.17	5.65	11.5	0.2	7.78	14.5	180	124	13.7	2.87	0	2.14
GASCONADE PWS	254	58.3	0	0.19	1.54	31.3	3.81	0	7.45	17.8	262	274	0	64.2	594	11.9
GASCONADE PWSD #1	281	55.2	0	0	1.07	40.2	1.84	0	7.54	23	282	303	0	56.9	589	4.09
GASCONY VILLAGE	221	45.7	0	0.22	1.71	28.1	2.31	0	7.69	13.5	222	230	0	6.03	13.6	0
GENERAL COUNCIL ASSEMBLIES	134	31.8	0	0	0	15.3	1.55	0	7.78	16.7	161	142	0	1.38	62.3	3.54
GERALD PWS	256	47.1	0	0	1.11	35.2	3.19	0.43	7.58	15.7	258	263	0	2.83	0	0
GIDEON PWS	258	7.37	51.9	0.21	3.44	1.51	123	0.028	7.91	12.4	334	24.6	0	34.4	40.6	4.01
GLADLO WATER & SEWER INC	291	64.9	0	0	0.88	38.3	2.49	0.063	7.81	34.4	322	320	0	179	72.9	0
GLADSTONE PWS	125	30.2	34.6	0.25	7	13.7	56.2	0.041	8.04	147	327	132	0	4.01	12.1	1.31
GLASGOW PWS	176	19.3	35.1	0.72	2.86	15.4	18.3	0.017	7.94	37.3	187	112	0	3.46	0	0
GLEN MEADOWS	336	59.5	59	1.72	8.15	28.8	68.6	0.095	7.71	73.7	470	267	0	13	19.4	0
GLEN OAKS SUBD	343	77.4	10.3	0.16	2.73	41.5	3.24	0	7.43	19.9	330	364	0	4.87	5.11	0
GLENBROOK ESTATES	282	58.9	45	1.56	6.88	29.1	58.6	0.057	7.44	85.7	450	267	0	2.47	96.8	3.34
GOBBLERS KNOB MOBILE HOME	272	64.2	0	0.2	3.57	33.7	1.75	0.018	7.59	32.2	299	299	0	1.93	168	4.03
GOBBLERS MOUNTAIN/PARKVIE	307	59.1	9.18	0	1.47	29.5	3.95	0.039	7.88	5.84	272	269	0	6.29	9.37	0
GOLD RIDGE NORTH	138	31.8	0	0.34	1.85	15.4	2.12	0.017	7.82	13.6	149	143	0	45	0	0
GOLDEN CITY PWS	171	30.9	0	0	1.21	15.6	3.41	0	8.02	9.72	144	141	0	20.3	35.4	0
GOLDEN GLADE WATER SYSTEM	235	62	53.3	0.31	4.33	31.8	17.6	0	7.61	23.1	329	286	0	1.44	496	0
GOLDEN OAK VILLAGE SUBD	216	53.3	0	0	1.92	27.4	2.41	0	7.89	38	262	246	0	3.36	94.6	2.2

Inorganic Chemical Analyses

SUPPLYNAME	mg/L (parts per million) Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	ug/L (parts per billion) Al	Cu	Fe	Mn
GOOD SAMARITAN BOYS RANCH	208	51.2	0	0	1.41	25.2	2.57	0.013	8.11	26.4	230	232	0	14	31.3	0
GOODMAN PWS	138	27	5.75	0.54	1.28	12.4	8.48	0	7.86	15	136	118	0	6.74	11.8	0
GRAHAM PWS	198	64.5	30.8	0.18	0	13.2	15.5	3.09	7.26	27.2	280	215	0	17	5.04	2.87
GRANBY PWS	140	34.8	5.39	0.21	1.33	16.3	7.08	0	7.92	14.6	157	154	0	9.74	24.2	1.4
GRANDIN PWS	235	40.8	0	0	0.76	24.3	2.44	0.09	7.87	0	192	203	13.2	10.9	12.8	0
GRANDVIEW PLAZA MHP	309	65	26.5	0.12	0.58	42.9	13.4	0.053	7.6	18.9	387	339	0	24.4	236	12.5
GRAYHAWK WATER	211	44.9	0	0	0.51	25.3	1.82	0.28	7.71	0	207	216	0	0	23.6	0
GREAT CIRCLE	210	48.9	0	0	0	28.3	2.77	0	7.81	31	241	239	0	21.7	17.5	3.39
GREEN ACRES HOMEOWNERS AS	287	65.1	0	0	1.95	36.9	1.24	0	7.53	32.1	315	315	0	9.16	236	1.43
GREEN ACRES MOBILE HOME PA	306	65	8.02	0	1.31	38.3	3.24	1.03	7.47	5.95	313	320	0	4.57	0	0
GREEN RIDGE PWS	337	63.5	0	0.5	2.28	36.7	17	0	7.44	20.1	312	310	0	19.8	825	6.62
GREEN SHORES SUBD	241	48.8	0	0	1.25	26.8	1.7	0	7.53	19.9	251	233	0	8.12	21.7	1.41
GREEN WOODS	292	57.9	5.76	0	1.02	33.2	2.55	0.06	7.61	6.35	287	281	0	397	0	0
GREENE COUNTY PWSD 1	175	33	0	0.5	1.39	21.6	2.64	0	7.84	14.4	195	149	0	49.3	55.7	0
GREENE COUNTY PWSD 5	203	44.7	5.52	0	1.39	24.5	3.33	0.033	7.6	16.4	207	219	0	1	8.23	1.24
GREENE COUNTY PWSD 6	149	35.5	0	0	1.12	17.5	1.64	0	7.78	16.7	168	161	0	8.16	228	4.31
GREENE HILLS WATER ASSN	250	41.9	8.16	0.28	2.87	19.8	5.04	0	7.61	16.4	207	186	0	17.8	57.9	1.3
GREENFIELD PWS	163	34.2	0	0.2	1.68	15.7	4.97	0	7.91	14.5	156	150	0	4.74	29.7	0
GREENVILLE PWS	181	39.7	0	0	0	23.2	1.31	0.29	7.84	0	179	195	13	17.8	7.19	0
GREENWOOD VALLEY	273	59.4	0	0	1.78	34.5	4.7	0.11	7.54	30.5	327	290	0	19.4	0	0
HALFWAY PWS	283	73	0	0.15	2.48	37	3.65	0	7.39	33.7	314	335	0	10.7	112	1.88
HALLTOWN PWS	119	27.7	0	0	1.23	15	1.52	0	7.84	8.64	126	131	0	0	146	2.22
HAMILTON PWS	125	28	25.8	0	5.31	4.23	14.9	0.13	7.67	8.57	151	87.3	29	70.9	0	0
HANNIBAL PWS	184	56.2	30.1	0.74	2.46	21.4	14.3	1.24	7.72	38.9	285	228	93.3	7.61	0	0
HARRISON COUNTY PWSD 2	376	60.5	46.9	0.43	4.07	19.3	135	0.27	8.02	90.9	576	231	0	2.1	17.3	0
HARRISONVILLE PWS	114	39.7	20.6	0.59	4.63	4.97	11.9	0.79	7.7	12	167	120	28.8	1.57	0	0
HARRY S TRUMAN PWSD 2	131	54.7	22.8	0.14	7.28	9.97	18.8	0.51	7.9	56	258	178	0	78	0	0
HARTVILLE PWS	164	38.8	0	0	1.13	21.3	1.14	0	7.9	7.76	176	185	0	1.01	76.2	0
HATTON HILLS MHP	317	74.9	0	0.29	4.26	38.1	17.7	0	7.3	33.3	380	344	0	19.4	132	3.15
HAWK ISLAND ESTATES	313	68.4	11.5	0	1.22	37.4	6.7	0.047	7.53	11.8	334	328	0	50.9	14.9	0
HAWK POINT PWS	1650	62.2	177	2.11	10.3	30.6	144	0	7.84	89.3	681	281	0	27.4	142	2.97
HAWKS NEST CONDO ASSN	352	78.8	56.9	0	2.44	47.1	19.1	1.28	7.32	14.2	444	391	0	71.9	20.8	0
HAYFIELD WATER WORKS	291	62.5	0	0	1.05	35.5	2.47	0	7.51	20.2	298	302	0	0	216	1.93

Inorganic Chemical Analyses

	mg/L (parts per million)												ug/L (parts per billion)			
SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
HAYTI HEIGHTS PWS	236	63.8	12.6	0.23	2.3	15.4	14.7	0.1	7.65	36.4	305	223	0	9.34	40.5	0
HAYTI PWS	164	6.6	6.12	0.11	5.9	2.44	61.3	0	7.22	17.9	193	26.5	0	80.2	10.2	0
HAYWOOD CITY PWS	69.3	31.4	9.5	0.12	1	5.41	5.75	1.95	7.86	25	147	101	0	0	342	269
HEIM MHP	213	51.7	6.53	0	1.02	22	3.29	1.35	7.59	7.95	219	220	0	4.9	0	0
HENRY COUNTY WATER COMPA	137	53.1	22.2	0	6.8	9.53	29.9	0.53	7.78	90.1	296	172	27.9	29.8	0	0
HENRYS MOBILE HOME PARK	284	56.1	0	0	1.74	32.3	2.98	0.098	7.78	0	266	273	0	7.86	5.37	0
HERMANN PWS	237	49.3	33.5	0.14	1.72	39.8	3.62	0.022	7.78	14.8	274	258	0	95.1	63.2	3.87
HERMIT HOLLOW SUBD	340	69.7	0	0.14	1.65	37.8	3.81	0.076	7.4	23.5	333	330	0	0	6.3	3.77
HERMITAGE PWS	319	61.9	5.74	0.22	2.58	27.4	5.87	0	7.46	17.9	267	260	0	25.1	98.4	2.45
HIDDEN HILLS ESTATES	293	63.5	0	0.9	5.18	32	18.3	0	7.66	26.2	315	290	0	9.07	64.5	2.66
HIDDEN OAKS ESTATES	348	0	0	0	0	0	149	0.088	7	6.79	368	0	0	15.2	0	0
HIDDEN RIDGE ESTATES MHP	228	50.3	0	0	0	24.7	1.16	0.035	7.61	9.76	232	227	0	0	0	0
HIDDEN SHORES SUBD	222	44	0	0	1.45	25.7	2.35	0	7.65	14.4	213	216	0	3.46	16.9	1.64
HIDDEN VALLEY FISHING CLUB	214	40.2	0	0.11	0.67	23.1	2.52	0.17	7.68	6.51	216	196	0	3.86	0	0
HIDDEN VALLEY MHP	280	68.2	59.5	0.27	3.09	32.4	32	0	7.55	19.5	380	304	0	4.78	580	5.83
HIDEAWAY MHP	335	75.5	0	0	1.57	45.1	1.83	0.67	7.58	14.4	339	374	0	8	0	0
HIGGINSVILLE PWS	144	37.5	15.5	0.69	5.93	7.84	8.07	0.4	8.16	29.5	176	126	13.1	2.15	0	0
HIGH HILL PWS	288	70.2	44.9	2.12	11.2	40.1	68.9	0	7.46	209	632	340	0	106	554	6.32
HIGH POINT ESTATES	199	42.5	0	0	0.94	25.1	2.04	0.22	7.79	11.1	210	209	0	1.82	25.6	0
HIGH RIDGE MANOR SUBD	259	59.7	0	0.47	2.92	28.2	1.29	0	7.81	19.6	268	265	0	0	252	2.76
HIGHLANDS SEWER & WATER AS	289	61.9	0	0	1.65	33.7	2.74	0	7.73	17.6	270	293	0	4.35	201	2.17
HIGHLANDVILLE PWS	252	48.6	6.48	0	1.29	24.9	3.08	0.7	7.72	8.98	223	224	0	3.35	0	0
HILLCREST UTILITY OPERATING	323	87.3	20.8	0.13	0.98	24.2	11.5	0.85	7.34	7.82	351	318	0	2.7	0	0
HILLSBORO PWS	298	62.1	0	0	1.25	34.9	1.92	0.044	7.56	21.9	293	299	0	8.04	7.49	0
HILLSHINE ACRES SUBD	366	69.5	12	0	1.23	42.4	15	1.77	7.29	23.1	368	348	0	4.58	5.38	0
HILLTOP WATER CORP	247	52.8	0	0.11	1.51	27.7	1.94	0.035	7.85	16.7	250	246	0	5.63	182	3.32
HOLCOMB PWS	268	5.72	46.7	0.31	3.36	1.29	148	0.01	8.37	10	377	19.6	0	16.5	47.9	2.98
HOLDEN PWS	124	22.5	20.5	0.21	5.38	4.57	17.9	0.36	7.69	7.87	142	75	31.9	4.21	0	0
HOLIDAY HILLS 1 2 3 ADDITION	335	70.6	7.65	0	1.69	42.9	3.41	0	7.14	20.6	382	353	0	4.35	0	6.5
HOLIDAY HILLS RESORT	286	50.1	6.13	0	1.72	27.2	2.09	0	7.71	17.8	256	237	0	1.6	28.4	1.35
HOLLISTER PWS	297	62	0	0	1.24	32.9	1.92	0	7.84	12.1	254	290	0	62.9	0	0
HOLTGREWE FARMS SUBDIVISIO	284	59.8	0	0.12	1.1	37.7	2.48	0.083	7.5	11.1	280	305	0	1.24	356	3.95
HOMETOWN COURT	325	93.1	38.2	0.94	5.9	42.7	48.3	0.54	7.43	149	561	408	0	3.62	82.2	2.22

Inorganic Chemical Analyses

	mg/L (parts per million)												ug/L (parts per billion)			
SUPPLYNAME	**Alk**	**Ca**	**Cl**	**F**	**K**	**Mg**	**Na**	**NO3**	**pH**	**SO4**	**TDS**	**TH**	**Al**	**Cu**	**Fe**	**Mn**
HOOT OWL POINT SUBD	285	60.4	7.63	0	1.6	34.4	3.23	0.016	7.34	10.8	309	292	0	26	16.9	1.14
HOPKINS PWS	217	70.9	41.4	0	2.25	10.8	33.1	0.026	7.19	58.8	365	222	15.6	1030	44.7	3.56
HORIZON MHP	226	56	6.45	0	1.48	28.7	1.23	0.046	7.73	21.2	251	258	0	4.75	0	0
HORIZON WEST SUBDIVISION	230	52.7	0	0.16	3.2	25.5	2.54	0	7.74	28.5	249	237	0	131	27.3	1.8
HORNERSVILLE PWS	540	2.11	5.42	0.61	1.35	0	263	0	8.56	15.6	635	9.39	0	15.2	36.3	2.13
HORSE SHOE BEND	233	49	0	0	1.66	28.4	3.88	0.5	7.55	8.03	218	239	0	2.31	17.6	0
HOUSTON PWS	241	62.3	0	0	0.94	31.2	1.99	0.95	7.5	5.9	296	310	0	11.3	0	0
HOUSTONIA PWS	322	67.1	17.1	1.01	6.48	32.7	41.4	0	7.62	79.9	388	302	0	2.77	752	11.3
HOWARD COUNTY REGIONAL W	190	18.1	127	0.22	4.69	17.8	74.1	0.023	8.45	32.1	368	118	0	2.37	6.44	0
HOWELL COUNTY PWSD 1	200	40.4	0	0	1.13	23.4	1.57	1.09	7.78	0	198	197	0	38.1	0	0
HOWELL COUNTY PWSD 3	253	51.7	0	0	1.35	31	1.38	0.024	7.81	0	243	257	0	6.03	86.7	14.1
HOWELL OREGON 2 WEST	262	49	0	0	1.58	31.5	1.7	0.024	7.54	5.17	239	252	0	7.67	12.1	9.27
HOWELL OREGON COUNTY PWS	252	52	0	0	1.41	31.9	1.25	0.07	7.84	5.55	263	261	0	54	7.84	0
HOWELL OREGON COUNTY PWS	238	49.1	0	0	1.64	29.3	1.36	0.092	7.72	0	243	243	0	110	0	0
HUGHESVILLE PWS	361	94.6	8.05	1.14	10.5	44	42.2	0.24	7.29	191	595	417	0	30.9	8.69	4.94
HUMANSVILLE PWS	285	54.5	0	0	1.61	34.2	4.95	0.73	7.78	15	234	241	0	13.5	203	5.74
HUNTERS GLEN	268	61.5	0	0.17	2.49	30.1	2.32	0	7.49	24.1	312	278	0	11.2	118	2.5
HUNTERS RIDGE SUBD	313	57.8	5.3	0	1.12	40	10.7	0.33	7.4	54.8	333	309	0	6.71	6.61	0
HURLEY PWS	138	31.9	0	0.12	1.36	16.4	1.72	0	7.92	13.4	149	147	0	6.17	31.2	0
HWY 43 MOBILE HOME & RV PAR	148	33.5	0	0.47	2.73	15.1	4.8	0.046	7.94	14.7	158	146	0	1.33	0	0
IBERIA PWS	320	63.1	0	0	1.72	37	3.71	0	8.06	16.4	280	310	0	14.6	33.6	0
INDEPENDENCE PWS	54.2	17.8	27.2	0.24	7.46	19.4	57.9	0.64	9.81	167	326	124	0	3.86	0	0
INDIAN HILLS HOMEOWNERS AS	340	67.6	8.96	0	1.37	42.5	4.89	0.5	7.43	11	353	344	0	75.3	7.98	3.57
INDIAN HILLS UTILITIES OPERATI	259	47.5	0	0	0.76	31.7	3.69	0.37	7.61	26.2	251	249	0	45.9	0	0
INNSBROOK	349	64.7	44.2	1.48	9.2	33.7	60.8	0.012	7.34	94.6	498	300	0	5.68	47	1.9
IONIA PWS	236	49.6	0	0	0	31.1	3.88	0	7.59	30.1	259	252	0	0	326	3.95
IRIS ROAD LLC	122	30.9	0	0.46	1.99	12.8	3.21	0.025	7.92	15.2	135	130	0	56.8	11.4	1.33
IRONDALE PWS	357	72.9	8.67	0.19	1.8	42.7	24.8	0.62	7.37	25.7	411	333	0	13	15.1	4.66
IRONTON PWS	176	13.5	6.25	0	1.44	7.9	17.9	0.28	7.47	49.1	137	66.2	19.7	2.63	0	0
ISLA DEL SOL	308	65.7	5.18	0.12	1.5	37.1	5.96	0.014	7.68	9.3	322	317	0	4.49	45.5	0
J BAR H ESTATES	383	71.5	0	0	0	44.4	2.15	0.13	7.56	0	352	361	0	15.5	0	0
JACKSON PWS	276	55.8	11.8	0.75	2.02	27.7	5.19	0.084	7.6	17.8	267	253	0	333	11.3	0
JAMES RIVER ADDITION	127	30.4	0	0	0	15.1	1.55	0	7.8	11.9	160	138	0	3.75	13.6	0

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
JAMES RIVER ESTATES SUBD	138	33.4	0	0.11	1.16	16	2.01	0	8.08	12	145	149	0	9.4	37.6	0
JAMESTOWN PWS	296	59.7	0	0.5	3.55	27.8	7.42	0	7.64	22.8	253	260	0	3.01	146	3.44
JASPER COUNTY PWSD 1	163	31.9	5.93	0.31	1.74	15.7	5.89	0	7.84	15.8	148	144	0	27.7	27.9	18.3
JASPER COUNTY PWSD 2	214	47.1	8.14	0.45	1.68	15.9	18.5	0.059	7.52	44.6	248	406	0	84.3	750	9.87
JASPER PWS	807	39.1	11.8	0.3	2.55	17.9	14.1	0	7.76	16.4	196	171	0	31.4	40.5	0
JEFF COUNTY REHAB PARTNERS	319	0	0	0.2	1.51	0	163	0	7.43	22.3	368	0	0	5.44	66.3	0
JEFFERSON COUNTY PWSD 5	341	80.4	5.92	1	1.68	46.6	5.8	0	7.37	88.3	404	393	0	11.5	31.2	0
JEFFERSON COUNTY PWSD 6	317	66.8	10.1	0.12	1.65	30.8	6.8	0	7.47	21	279	257	0	7.56	0	0
JEFFERSON COUNTY PWSD 7	349	77.6	5.1	0.83	1.81	41.2	4.5	0.23	7.48	57.8	386	363	0	134	0	4.24
JEFFERSON COUNTY PWSD 8	271	62.8	0	0.11	1.95	32.5	6.55	0.19	7.47	23.9	256	283	0	4.3	0	0
JEFFERSON COUNTY PWSD 12	379	67.9	8.58	0	0	40.2	5.85	0.32	7.37	28.9	364	335	0	12.1	0	0
JEFFERSON COUNTY PWSD 2	62.5	19	15.1	0.52	2.11	14.4	6.74	0.11	10.05	37.8	165	107	0	0	0	1.76
JEFFERSON COUNTY WATER AUT	49.4	14.1	31.8	0.64	4.65	15.2	32.4	0.092	7.76	89.2	223	97.8	0	1.03	0	0
JOHNS BRANCH WATER CO	287	57.7	0	0	0	31.7	3.31	0.14	7.67	0	264	275	0	5.58	0	0
JOHNSON BAY SUBDIVISION	305	55.7	0	0	0.7	36	2.07	0	7.42	8.92	286	304	0	99	5610	69.4
JOHNSON COUNTY PWSD 2	297	57.7	47.2	0.42	3.1	28.2	31.7	0.012	7.8	30.6	340	260	0	2.18	11.6	1.72
JOHNSON COUNTY PWSD 3	259	46.7	48.3	0.68	3.58	23.6	39.3	0	7.44	29.6	312	223	0	2.79	39.2	1.97
JONESBURG PWS	271	77.8	24.2	1.99	10.2	47.1	42.3	0	7.47	156	382	388	0	9.92	179	5.14
JOYCE RENTALS	357	86.6	21.2	0	1.68	49.4	19.2	2.36	7.26	124	512	420	0	4.22	6.14	0
KAHOKA PUBLIC WORKS	203	65.1	54.4	1.15	3.05	12.7	57	0	7.49	131	411	215	0	6.31	874	127
KANSAS CITY PWS		43.3	26	0.638	6.37	5.28	53.8	1.39	10.1	195	330		0	0	0.004	0
KEARNEY PWS	139	29.4	35.6	0.65	2.12	17.5	19.7	0.035	8.69	50.3	217	145	192	2.79	6.31	0
KEITHLEY BEACH SUBD	330	66.9	0	0	0.9	41.5	2.14	0.13	7.44	8.22	365	408	0	22.2	0	0
KELSO PWS	268	60.8	16	0.22	1.38	29.1	11.4	0.51	7.5	10.4	292	272	0	4.75	0	0
KENNETT PWS	305	3.06	44.3	0.33	2.21	0	164	0.014	8.33	8.59	393	11.8	57.4	4.15	149	3.39
KEYTESVILLE PWS	122	17.7	28.4	1.19	1.68	9.22	13.3	0.14	7.72	5.84	146	82.2	0	72.9	110	4.65
KILLARNEY SHORES SUBD	180	38.8	6.56	3.79	0	9.41	33	0	7.77	13.1	242	138	0	58.1	100	30.7
KIMBERLING AIRWAYS SUBD	321	60.6	18.7	0	1.98	34.4	4.63	0.046	7.71	10.4	315	293	0	3.51	22.1	0
KIMBERLING CITY OF GOLDEN A	231	44.7	0	0	1.07	24.5	2.48	0.014	7.57	19.7	249	213	0	57.8	8.98	1.28
KING CITY PWS	138	33.2	16.5	0.14	4.99	5.9	10.6	0.013	7.95	10.8	157	107	119	27.6	0	0
KINGDOM CITY PWS	339	71.9	0	0.23	3.37	33.6	13	0	7.43	24.7	323	318	0	1.69	34.2	2.12
KINGS RIVER BEACH WATER ASS	314	58.5	0	0	1.42	32	3.37	0	7.47	14.4	289	278	0	119	14.8	0
KINGSTON PWS	279	67.7	30.5	0.2	1.22	9.7	51.9	0	7.85	25.8	375	209	0	11.9	539	126

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
KIRKSVILLE PWS	116	43.9	14	0.58	2.42	6.42	6.36	0.048	7.64	21.3	166	136	79.7	5.08	0	0
KK WATER SUPPLY	396	80.7	5.44	0	0.94	47.8	4.05	0.035	7.46	15	391	398	0	132	0	2.55
KNOB HILL ACRES	276	55.3	0	0	1.1	29.7	2.8	0.034	7.79	15.7	278	260	0	5.97	81.1	1.95
KNOB NOSTER PWS	287	52.9	24.7	0.47	3.36	26.3	23.9	0	7.86	36.8	325	240	0	8.87	1450	1.46
KOSHKONONG PWS	280	58.9	0	0	1.78	32.8	1.78	0.65	7.62	6.81	267	282	27.8	86.2	16.3	0
KUHLE H20	309	68.3	26.9	1.04	9.14	33.1	56.8	0.014	7.39	71.5	454	307	0	116	51.1	2.89
LA MONTE PWS	366	76.5	13.7	1.5	9.4	37.3	35.7	0	7.27	98.2	461	345	0	4.43	115	3.4
LACLEDE COUNTY PWSD 1	249	51.6	0	0	1.02	30.7	1.48	0.08	7.74	9.33	251	255	0	168	0	0
LACLEDE COUNTY PWSD 2	237	48.3	0	0	0	36.7	2.18	0.48	7.57	5.26	293	239	0	15.9	0	0
LACLEDE COUNTY PWSD 3	205	40.4	0	0	0	23.9	1.91	0.23	7.87	12.7	209	199	0	61.6	0	0
LADDONIA PWS	241	16.4	94.5	0.89	12.5	26.2	131	0.033	8.1	204	511	149	18.7	3.66	5.07	0
LAGRANGE PWS	185	54.2	27.4	0.48	2.37	17.4	10.8	0.12	7.81	28.6	292	207	0	59.1	0	0
LAKE ADELLE SUBD	305	55.3	0	0	1.38	32.3	3.66	0.045	7.86	15.7	279	271	0	36.8	5.65	0
LAKE COUNTRY VILLAGE POA	242	46.2	0	0	1.12	25.4	2.26	0	7.86	20	212	220	0	14.7	5.02	0
LAKE FOREST ESTATES	291	58.5	0	0	0.98	36.5	3.46	0.23	7.69	12.9	121	296	0	96.9	12.6	0
LAKE FOREST SUBDIVISION	320	67.7	5.88	0.1	2.08	33.8	4	0	7.55	66.6	332	308	0	0	36.9	3.17
LAKE FOREST SUBDIVISION	315	58.9	21.9	1.38	7.89	29.1	46.1	0.071	7.49	46.6	396	267	0	28.6	104	4.9
LAKE HILLS PARK	408	110	0	0.21	3.08	54.3	4.6	0	7.55	108	528	498	0	1.9	14.9	0
LAKE KAH TAN DA ESTATES INC	237	42.4	0	0	0.52	24.7	2.08	0.08	7.74	0	217	208	0	3.58	0	0
LAKE LORRAINE WATER CO	280	72.7	0	0.1	1.33	29.3	2.2	0.092	7.44	23	303	302	0	3.11	15.3	0
LAKE MEADOWS MHP	219	56.7	0	0	1.09	26.3	2.7	0.024	7.85	59.6	290	250	0	12.9	66.9	1.42
LAKE NORTHWOODS UTILITY IN	242	51.9	0	0.13	1.74	34.8	4.82	0	7.87	32.9	279	273	0	1.99	1680	10.4
LAKE OZARK PWS	313	66.4	7.6	0.2	2.81	36.8	8.9	0.062	7.68	15.2	309	317	0	16.4	9.08	3.53
LAKE RIDGE BAY	332	86.6	0	0.16	1.73	47.9	3.03	0	7.61	70	426	413	0	8.82	176	2.98
LAKE SEVEN FALLS ASSN INC	113	22.2	5.44	0.1	1.71	7.84	4.37	0.44	6.75	0	106	87.7	0	11.4	0	0
LAKE SHERWOOD SUBD	304	61.9	21.8	1.34	7.02	29.2	27.8	0.032	7.4	56.4	368	275	0	3.27	0	1.27
LAKE TANEYCOMO WOODS	312	60	0	0	1.82	33.9	3.23	0	7.58	12.1	293	300	0	0	73.1	1.24
LAKEHURST MHP	305	67.4	0	0.18	3.03	29.9	3.87	0.042	7.38	19.7	302	291	0	3.4	9.46	0
LAKELAND HEIGHTS WATER CO	228	47.7	0	0	0.7	27.3	1.84	0.046	7.66	11.4	234	232	0	3.41	32.5	0
LAKESIDE AT CROSS CREEK	342	69.3	0	0	0	42	2.29	0.044	7.37	12.3	344	346	0	45.7	244	2.16
LAKESIDE COMMUNITY INC	267	75.4	0	0	0.89	47.4	3.2	0	7.65	121	423	383	0	69.6	548	3.64
LAKESIDE ESTATES SUBD	274	58.4	0	0.11	1.23	36	2.67	0.24	7.57	10.7	264	294	0	1.54	9.18	0
LAKESIDE MANOR	289	66.7	0	0.11	1.33	36	4.01	0	7.5	23.6	318	315	0	9.77	279	2.98

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
LAKESIDE MOUNTAIN MANOR	379	85.4	36.1	0	5.07	47.7	12.7	0.99	7.33	39.1	439	410	0	9.77	12.7	1.62
LAKEVIEW SUBD BLOCK C	290	57.9	0	0	1.42	28.1	2.27	0.17	7.56	18.8	276	260	0	17	21.6	5.5
LAKEWOOD HEIGHTS SUBD	278	69.9	0	0	1.34	33.8	8.55	0.015	7.33	28.7	323	314	0	28.7	87.7	3.54
LAKEWOOD HILLS SUBD	318	54.6	21.5	0.12	0	31.7	1.53	0.029	7.66	13	262	259	0	2.31	5.12	1.06
LAMAR PWS	115	25.5	11.7	0.66	4.26	3.87	18.8	0.032	7.63	54.2	164	79.6	149	0	0	1.37
LANAGAN PWS	190	26.3	29.8	0.64	2.46	11.9	30.8	0	7.98	13.4	187	115	0	8.7	53.3	1.45
LANTERN BAY RESORT CONDO	289	59.2	0	0	1.12	26.7	2.43	0.076	7.64	11.9	247	258	11.3	5.94	7.06	0
LAUREL ACRES MHP	314	99.6	19.4	0	1.88	15	10.1	1.23	7.53	16.1	347	310	0	3.46	0	0
LAURIE PWS	254	52.2	0	0	1.29	30.2	1.91	0	7.67	16.8	246	255	0	92.9	12.8	2.4
LEAD M THE OAKS	231	51.2	0	0	0	31.2	2.41	0.24	7.57	18.1	231	256	0	28.2	0	0
LEADWOOD PWS	284	122	15.3	0	2.61	64.4	11.3	0	7.32	356	769	570	0	31	862	9.91
LEASBURG PWS	151	29.1	0	0	0.82	19.6	1.86	0.17	7.83	5.03	157	153	0	64.5	7.34	0
LEBANON PWS	210	38.6	0	0.18	1.15	21.7	1.9	1.39	7.65	11.3	198	186	0	4.44	61.4	2.13
LEETON PWS	229	53.7	127	0.87	5.9	23.2	79.8	0	7.58	43.3	463	230	0	9.51	198	4.58
LEISURE SHORES UNIT 2	311	59.7	0	0	1.55	30.3	2.48	0	7.35	13.6	293	274	0	39.9	15	1.08
LEONARDS MOBILE HOME PARK	242	59.7	0	0.19	0	27.4	1.4	0	7.6	18.5	264	262	0	16.1	47.5	0
LEXINGTON PWS	139	54.1	49.8	0.32	9.49	23	64.8	2.78	7.86	177	472	230	0	722	23.3	0
LIBERAL PWS	238	45.3	110	0.53	5.06	22	87.2	0.02	8.05	17.4	409	204	0	6.39	66.6	1.52
LIBERTY PWS	156	28.4	21.6	0.87	5.9	26.8	19.5	0.074	8.38	50.2	270	181	0	142	77.4	3.6
LIBERTY WATER NOEL	127	27.8	37	0.66	2.24	12.6	32	0	7.86	14.8	201	121	0	9.26	303	12.2
LICKING PWS	180	38.7	0	0	1.29	20.9	1.67	0.23	7.77	0	172	183	0	275	0	0
LIFE STYLE MHP	286	70.7	0	0.1	1.33	41.6	4.42	0.03	7.55	26.6	317	348	0	5.14	6.03	0
LILBOURN PWS	207	54.8	11.2	0.16	1.63	9.7	7.99	0	7.25	25.9	241	177	0	166	0	0
LINCOLN COUNTY PWSD 1	298	44.9	126	3.61	8.76	19.1	158	0	7.52	113	654	191	0	14.7	36.6	2.18
LINCOLN PWS	284	68.2	0	0.5	2.22	39.7	7.87	0	7.69	68.8	337	334	0	1.23	115	2.24
LINN ACRES	284	72.1	0	0.32	3.45	48.3	4.76	0	7.45	66.3	380	379	0	3.72	42.3	2.35
LINN COUNTY CONS PWSD 1	150	26.9	28.6	0.16	2.22	9.3	32.4	0.099	7.77	73.1	229	105	288	1.94	0	19.2
LINN CREEK PWS	264	63.1	0	0.14	1.1	34.6	2.46	0	7.55	12.3	269	300	0	5.95	115	1.05
LINN LIVINGSTON COUNTY PWS	184	7.61	38	0.74	2.55	14.4	75.9	0.77	8.37	14.7	278	78.3	199	2.3	9.23	0
LINN PWS	285	47.6	0	0	1.02	30.9	3.04	0	7.74	29	285	300	0	3.58	270	6.02
LIVINGSTON COUNTY PWSD 2	180	16.1	21.4	0.12	1.58	13.3	37.2	0.17	7.94	69.9	275	95	124	2.41	0	2.72
LIVINGSTON COUNTY PWSD 4	364	81.1	25.1	0.21	2.81	12.9	51.2	0.02	7.8	27.1	400	256	0	132	23	1.39
LOCKWOOD PWS	146	28.7	0	0	1.2	14.6	2.1	0	8.11	9.7	139	132	0	2.48	61.3	1.1

Inorganic Chemical Analyses

	mg/L (parts per million)												ug/L (parts per billion)			
SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
LONGVIEW SUBDIVISION	318	59.3	5.54	0	1.23	30	3.09	0.32	7.43	11.4	318	272	0	159	0	0
LOOKOUT POINT SUBD	308	69.5	0	0	0	42.7	2.48	0.084	7.38	0	325	349	0	66.7	0	0
LOST CREEK WATER COMPANY	202	42.3	0	0	0.64	24.2	1.78	0.11	7.88	0	186	205	0	1.96	0	0
LOUISBURG PWS	330	58.5	5.53	0	1.44	32.6	6.02	0	7.57	22.8	289	280	0	16.8	662	5.82
LOUISIANA PWS	139	43.4	21.3	0.7	3.53	13.7	7.15	1.27	7.43	23.4	223	165	45.1	2.4	0	2.9
LOWRY CITY PWS	184	46.1	0	0.54	3.89	21.1	7.41	0	7.97	35.9	223	202	0	4.08	246	5.52
LUCKY LADY MOBILE HOME PAR	223	64.8	11.3	0	0	18	4.52	1.97	7.57	10.8	247	236	0	46.3	12.4	0
M & M MOBILE HOME PARK	286	48	83.9	1.23	6.39	22.6	85.2	0.012	7.68	49.6	428	213	0	2.43	136	2.8
MACKENZIE RIDGE LLC	281	57.4	0	0	1.13	33.5	3.24	0.05	7.23	17.2	285	281	0	54.3	0	0
MACON PWS	75.9	23	15.7	0.6	3.87	4.62	13.6	1.02	8.2	18.1	129	76.5	38	3.77	0	0
MADISON COUNTY PWSD 1 NORT	181	29.4	12.5	0	1.09	15.1	8.5	1.43	6.9	35.6	207	136	0	17.5	0	0
MAITLAND PWS	187	52.2	9.06	0.24	0	10.6	14.2	5.32	7.56	33.1	253	174	0	31.7	0	0
MAJESTIC LAKES	336	63	77.6	1.88	8.46	29.5	86.7	0	7.55	92.3	549	279	0	3.32	119	1.68
MAKALU ESTATES	316	65	6.16	0	1.12	36.3	4.57	0	7.5	8.38	307	312	0	1.02	100	33.1
MALDEN PWS	217	15.2	148	0.29	5.17	6.06	143	0	8.27	22.5	503	31	0	1.75	432	6.99
MALFUNCTION JUNCTION	274	82.7	22.6	0	1.32	21.7	6.18	0.56	7.51	15.7	352	296	0	4.56	0	0
MANDERLY MHP	373	79.4	0	0	1.9	44.1	5.74	0.19	7.32	57.6	410	380	0	0	321	4.93
MANSFIELD PWS	272	48.8	0	0	0	25.7	1.16	0.11	7.54	11	231	228	0	9.17	7.91	0
MAPLE HILL PARK	341	80.3	16.7	0.11	2.37	45.1	11.9	0.16	7.36	37.1	415	386	0	5.96	20.7	0
MAPLE RIDGE MHP	365	66.7	23	1.48	11.4	33.5	47.4	0.034	7.8	58	435	305	0	4.86	40.7	1.81
MARBLE HILL NORTH PWS	305	56.6	0	0	0.52	31.7	2.4	0.58	7.37	0	263	272	0	21	0	0
MARBLE HILL SOUTH PWS	288	57	5.67	0	1.52	31.5	2.39	0.56	7.42	0	269	272	0	15.5	0	0
MARCELINE PWS	85.8	13.2	41.8	0.63	5.25	4.44	40.1	0.084	8.1	14.3	166	51.2	931	5.21	8.42	4.79
MARIES COUNTY PWSD 1 NORTH	133	29.1	0	0.16	0.57	16.8	1.5	0	7.93	0	134	142	0	2.68	50.6	0
MARIES COUNTY PWSD 1 SOUTH	264	68.3	0	0	1.32	40.7	3.5	0	7.53	83.9	358	338	0	76.9	265	4.47
MARIONVILLE	155	36.6	0	0	1.35	19.1	3.24	0	7.98	5.76	169	167	0	11.9	46.4	0
MARQUAND PWS	638	50.4	419	1.73	6.37	25.7	348	0	7.98	213	1100	232	0	9.52	152	23.4
MARSHALL PWS	240	28.1	90.8	0.28	3.3	20.2	53.1	0.1	7.56	6.95	316	153	0	12.7	263	72.2
MARSHFIELD PWS	229	65.8	0	0	1.86	34.2	4.07	0.17	7.61	69.9	323	305	0	72	74.8	4.52
MARSTON PWS	201	63.2	16.9	0.16	2.24	13	12.4	0.036	7.43	19.9	265	211	0	20.6	0	0
MARTHASVILLE PWS	289	61.2	0	0.13	1.22	34.6	3.08	0.036	7.57	20.5	297	295	0	0	0	0
MARTINSBURG PWS	358	53.4	28	2.54	13.8	26	126	0	7.51	121	555	240	0	11.4	428	5.89
MARYVILLE PWS	123	35.2	12.3	0.25	3.55	7.64	8.52	0.044	8.03	8.09	143	119	12.1	21.9	0	2.42

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
MATTHEWS PWS	146	30.3	5.14	0.6	2.51	8.47	14.9	0	7.39	7.15	157	111	0	15.9	22.9	1.48
MAYSVILLE PWS	164	37.9	22.4	0.15	5.79	7.12	7.64	0.55	7.64	22.3	166	124	17	2.95	0	1.02
MC COUCH DRIVE HOA	272	54.5	0	0	0.95	33.2	1.85	0.11	8.02	0	267	273	0	2.81	0	0
MC DONALD COUNTY PWSD 1	164	31.1	63.4	0.9	2.26	14.3	45.9	0	7.82	15.8	260	137	0	4.82	18.6	0
MC DONALD COUNTY PWSD 2	154	30.4	6.58	0.23	1.24	14.4	6.25	0	8.03	12.3	149	135	0	83.6	40.5	1.7
MC DONALD COUNTY PWSD 3	136	36.1	327	1.15	4.84	15.5	216	0	7.25	9.25	680	154	0	13.6	111	2.84
MEADOW DRIVE SUBD	311	62.9	0	0.25	0	33.9	3.63	0.01	7.49	27.3	308	297	0	5.76	0	1.13
MEADOW HILLS SUBDIVISION	164	25.3	0	0.21	1.57	13.5	27.5	0	7.78	17.1	186	119	0	55.9	0	2.57
MEADOW RIDGE SUBDIVISION	527	64.1	14.6	0	1.76	33	8.06	0	7.72	24.9	300	297	0	2.92	0	4.49
MEADOWLARK ACRES MHP	279	58.8	0	0.16	0.99	33.8	3.81	0	7.62	17.8	277	286	0	7.76	187	3
MEADOWOOD ESTATES SUBD	323	66.3	11.2	0	1.28	41	2.45	0.52	7.86	27.6	349	334	0	2.12	0	0
MEADVILLE PWS	421	70	47.6	0.4	2.77	24.3	106	0.026	7.85	52.4	529	275	0	25	8.77	0
MELODY LAKE WATER & SEWER	263	48.5	0	0.1	0	34.5	3.75	0	7.87	26.9	267	263	0	3.52	105	4.43
MELODY MANOR SUBDIVISION	277	63.7	0	0.12	1.76	33.2	1.34	0	7.39	19.4	284	296	0	4.42	0	0
MEMPHIS PWS	100	30.1	17.7	0.4	4.42	6.16	7.13	0.039	7.69	23.5	144	101	198	23.3	0	0
MERITTS CAMPGROUND	236	51.1	0	0	1.16	28	2.31	0.045	7.48	14.6	241	243	0	0	348	2.68
MERRIAM WOODS VILLAGE OF P	222	42.5	5.7	0	1.22	23.4	1.71	0	7.71	14.8	205	213	0	5.21	35.4	1.47
META PWS	327	63.5	6.89	0	0	39.2	2.77	1.44	7.51	11.7	305	320	0	1.67	0	0
MID AMERICA TEEN CHALLENGE	163	0	0	0.14	0	0	83.4	0.47	7.58	11.7	204	0	243	7.03	26.7	1.35
MIDDLE FORK WATER CO	102	34.8	20.2	0.13	2.69	6.39	10.2	0.34	7.41	16.5	158	113	126	1.96	0	0
MIDDLETOWN PWS	458	35.1	16	1.78	17.5	19	193	0.011	7.46	158	730	166	0	122	30.7	1.53
MIDLAND WATER CO	235	33.5	5.42	0.28	1.94	17.7	4.54	0.011	7.88	14.8	178	157	0	4.19	7.19	0
MILL CREEK SHORES SUBD	356	73.3	0	0	0	41.6	2.83	0.18	7.53	6.66	333	354	130	3.42	111	93.6
MILL SPRING PWS	250	48.1	0	0	0	27.6	3.42	0.021	7.67	10.6	210	234	0	5.55	0	0
MILLER COUNTY CARE CENTER	287	59.8	0	0	0.94	34.7	2.05	0	7.39	15.4	287	292	0	135	10.1	0
MILLER PWS	228	55	21.1	0	0.81	18.7	12.7	1.92	7.85	0	179	177	0	65.1	0	0
MILLSTONE LUXURY CONDOMIN	361	76.8	34.4	0	0	46.6	12	0	7.48	8.96	385	384	0	11.4	31.8	1.69
MILLWOOD ESTATES PROP OWN	217	39	0	0	1.07	19.8	1.4	0	7.47	20.8	238	179	0	62.4	26	1.41
MINDENMINES PWS	248	42.7	66.1	0.55	4.11	18.5	57.5	0.019	7.85	10.8	328	183	0	10.5	17.4	1.08
MINER PWS	145	50.2	9.78	0.98	1.17	7.37	7.17	0	7.61	21.5	209	156	0	203	31.3	2.38
MINERAL POINT PWS	205	45.7	0	0.2	1.7	26.4	6.02	0.03	7.71	26.4	231	223	0	0	11.2	0
MINNOWBROOK ESTATES	307	63.7	0	0	0.67	37.7	1.46	0.34	7.45	0	279	314	0	136	0	0
MIRAMIGUOA PARK	325	61	5.19	0	0	39.2	2.68	0.66	7.75	12.4	322	314	0	4.45	0	0

Inorganic Chemical Analyses

	mg/L (parts per million)												ug/L (parts per billion)			
SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
MIRASOL SUBDIVISION	285	65.4	0	0.13	1.65	37.9	2.93	0	7.73	18	304	318	0	46.1	134	1.13
MISSIONARY ACRES	212	43.7	0	0	0	26.1	2.02	0.09	7.72	0	192	217	0	90.4	7.51	0
MISSOURI REHABILITATION CEN	171	32.6	0	0.14	1.74	15	5.41	0	8	11.8	149	143	0	81.5	31.9	1.89
MO AMERICAN ANNA MEADOWS	328	68	64	1.56	9.42	30	72.1	0.04	7.56	72.5	508	290	0	0	0.11	0
MO AMERICAN BRUNSWICK	265	42	24	0.24	0	20	13	0.28	8.18	38.5	226	295	0.03	0	0	0
MO AMERICAN EMERALD POINT	185	46	2.6	0	0.9	23	2.1	0.02	7.48	10.1	197	203	0	0	0	0
MO AMERICAN HICKORY HILLS	311	69.6	0	0.28	1.8	36.3	7.26	0.02	7.4	20.1	312	323	0	0.08	0	0
MO AMERICAN JAXSON	355	64.7	91.4	1.39	8.06	32.4	85.7	0.05	7.48	85	557	295	0	0	375	2.36
MO AMERICAN JEFFERSON CITY	64.1	40	18	0.81	7.51	5	31.2	2.59	9.13	103.4	391	153	0	0	0	0
MO AMERICAN JEFFERSON CITY	280	50	18.6	0.93	4.14	24.6	36.6	0	7.49	25.4	329	226	0	88	440	4.55
MO AMERICAN JOPLIN	140	44	3.4	0.95	0	21	3.6	0	7.76	17.8	136	131	0	0	0	0
MO AMERICAN LAKE CARMEL	340	62	2.6	0.16	0	33	5.7	0	7.53	15.6	306	300	0	0.036	0.13	0
MO AMERICAN LAKE TANEYCO	322	70	13	0	1.48	42	3.7	0.35	7.6	19.8	348	361	0	0.031	0	0
MO AMERICAN LAKEWOOD MAN	271	60	21	0	0	32	12.7	0.11	7.5	10.2	298	281	0	0.029	0	0
MO AMERICAN MAPLEWOOD SU	253	48	6.4	0.24	0	25	7.6	0	7.57	14.4	248	241	0	0	0	0
MO AMERICAN MEXICO	292	29	44.7	1.2	10	30	70.1	0.32	8.08	68.8	368	205	0.01	0.026	0	0
MO AMERICAN OZARK MTN WAT	241	56	2.2	0	1.06	27	2.2	0.02	7.78	10.6	250	254	0	0.117	0	0
MO AMERICAN OZARK MTN WAT	288	60	6.6	0	1.45	35	3.8	0.02	8.04	14	306	305	0	0.039	0.1	0.016
MO AMERICAN OZARK MTN WAT	316	61	3.3	0	2.05	31	2.7	0	7.71	15.9	318	294	0	0.052	0	0
MO AMERICAN PLATTE COUNTY	105	43	30.1	0.29	7	26	50.1	0.39	9.98	154.4	356	174	0	0	0	0
MO AMERICAN RANKIN ACRES S	202	49	8	0.23	0	20	5.8	0.02	7.87	18.5	228	177	0	0	0	0
MO AMERICAN RED FIELD SUBDI	270	48.4	0	0.12	0.71	28.2	4.7	0	7.57	25.4	277	237	0	0.135	349	2.23
MO AMERICAN RIVERSIDE ESTA	208	46	4.9	0	0	22	4.2	0	7.82	14.5	208	215	0	0	0	0
MO AMERICAN SADDLEBROOKE	219	48	2.7	0	1.09	27	1.9	0.01	7.71	9.7	228	242	0	0	0	0
MO AMERICAN ST JOSEPH	143	32	26.1	0.63	7	27	47.9	0.35	8.49	137	380	212	0	0	0	0
MO AMERICAN ST LOUIS ST CHA	54.4	15	34.7	0.63	2.55	16	18	0.89	9.69	14.5	183	128	0	0	0	0
MO AMERICAN STONEBRIDGE VI	222	46	2.3	0	0	23	1.3	0.02	7.65	10.5	214	245	0	0	0	0
MO AMERICAN TRI STATE	281	55	2.6	0	1.2	29	1.2	0	7.29	14.6	259	269	0	0.137	0	0
MO AMERICAN WARDSVILLE	312	66.2	0	0.11	0.98	38.2	4.33	0.48	7.36	20	319	323	11.6	106	28.5	0
MO AMERICAN WARREN COUNT	311	62	46.5	1.45	7.57	27	60.7	0.02	7.8	57	446	270	0	0	0.13	0
MO AMERICAN WARRENSBURG	238	53	74.6	0.71	0	25	46.4	0.02	7.73	35.7	364	209	0	0.092	0.2	0
MO AMERICAN WHITEBRANCH S	470	103	19.8	0	0	50	8.1	0.02	7.01	108.2	482	410	0	0	0.22	0
MO AMERICAN WOODLAND MAN	216	53	4.3	0	0.95	27	2.8	0.01	7.7	13.7	217	226	0	0	0	0

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
MO ARK WATER CO	213	39.1	0	0	1.53	21.7	3.29	0.076	7.82	9.33	197	187	0	22.7	0	0
MO EASTERN CORRECTIONAL CE	306	7.82	20.8	0.14	2.5	8.6	133	0.043	7.87	22.5	367	54.9	0	10.5	5.13	0
MO PARK CAMPGROUND	215	49.3	11.4	0	1.7	26.3	3.68	0.37	7.56	6.68	227	240	0	2.95	0	0
MOBERLY PWS	89.2	38.2	14	0.63	4.67	5.36	11.7	0.32	7.61	47.7	170	117	98.3	1.96	0	2.72
MOKANE WATER COUNTY OP	290	64.5	16.6	0.64	4.49	31.5	37	0	7.37	58.5	381	291	0	60.3	198	48.7
MONETT PWS	186	29.4	19.3	0.43	1.73	15.5	1.88	0.58	7.94	18.5	198	126	13.5	1.74	706	7.35
MONITEAU COUNTY PWSD 1	280	57.8	0	0.16	1.23	36.7	5.78	0	7.5	26.7	293	295	0	2.53	124	1.76
MONITEAU COUNTY PWSD 2	379	80.8	0	0.15	1.44	42.3	10.2	0	7.78	36.9	376	376	0	91.9	56.1	3.07
MONROE CITY PWS	98.7	42.6	9.25	0.28	5.19	2.38	1.77	1.16	7.01	79.5	169	116	39.1	0	0	27.8
MONSEES LAKE ESTATES	263	61.7	0	0.43	2.33	29.1	8.34	0	7.57	14.9	281	268	0	42.9	355	3.74
MONTGOMERY CITY PWS	396	17.4	66.6	1.98	4.78	8.95	230	0.023	7.78	153	692	80.3	0	52.7	24.3	0
MONTGOMERY CO PWSD 1	248	51.6	30.2	1.72	6.34	25.8	47.5	0	7.62	52.9	355	235	0	19.7	775	5.74
MOORE BEND WATER UTILITY L	323	59.2	5.53	0	1.06	36.4	3.49	0.61	7.32	20.3	321	283	0	5.3	0	0
MOREHOUSE PWS	215	68.7	29.1	0.14	2.77	12.8	19.4	0	7.31	37.8	310	224	0	22.9	6.8	0
MORGAN COUNTY PWSD # 2	331	73.4	0	0	0	44.1	2.46	0.22	7.74	11.1	330	365	0	6.24	0	0
MORLEY PWS	176	57.7	20.1	0.1	2.18	12	12	0.026	7.55	26.7	254	193	0	23	0	0
MORNINGSIDE CHURCH RETREA	186	43.4	0	0.12	1.91	25.3	1.62	0	7.87	12.3	197	213	0	22.1	14.1	2.16
MORRISON PWS	276	52.3	0	0.31	2.34	29.9	4.51	0	7.68	21.1	273	254	0	41.9	34.4	1.17
MORRISVILLE PWS	136	34.4	0	0.15	1.16	17.5	1.62	0	7.92	14.6	147	158	0	3.48	43.5	0
MOSCOW MILLS PWS	340	59.2	61.9	1.69	9.14	30.5	70.6	0.02	7.54	67.3	478	272	0	3.73	0	0
MOUND CITY PWS	242	43.6	60.4	0.19	2.61	34.9	28.8	0.028	8.22	64.3	402	253	0	0	0	0
MOUNT VERNON PWS	197	42	0	0	1.64	19.3	1.77	0	7.81	13.4	186	158	0	0	7.41	0
MOUNTAIN ESTATES	299	61.6	0	0	1.27	34.2	2.1	0	7.56	11.9	304	295	0	525	15.2	0
MOUNTAIN GROVE PWS	249	54.8	0	0	1.52	28.9	6.45	0.98	7.47	11.8	252	256	0	3.37	0	0
MOUNTAIN VIEW PWS	243	43.6	0	0	1.32	28.3	2.64	0.12	7.83	12.3	213	219	0	147	0	0
NEOSHO PWS	158	33.3	0	0	0	17	2.57	0	7.78	14.1	153	153	0	1.2	0	1.44
NEVADA PWS	112	24.1	188	0.24	3.6	11.2	122	0.015	8.27	77.1	433	106	0	7.7	16.6	0
NEW BLOOMFIELD PWS	352	68.7	6.04	0.69	3.13	32.3	18.6	0	7.21	20.5	368	293	0	94.6	59.3	2.77
NEW CHRISTIAN LIFE FELLOWSH	375	66.2	8.32	1.27	15.9	32.4	68.7	0.41	7.59	95	512	299	0	7.86	0	0
NEW FLORENCE PWS	218	56	17	1.96	5.38	28.3	38.2	0	7.68	29.8	310	256	0	1.28	132	12.1
NEW HAMBURG CENTRAL	226	50.7	23	0	0.58	28	18.8	6.42	7.47	0	334	242	0	9.99	10	0
NEW HAMBURG SOUTH END	281	70.7	36.7	0	0.89	36.9	26.5	4.75	7.49	32	418	328	0	9.93	5.66	0
NEW HAVEN PWS	278	49.5	0	0	1.12	36.4	3.28	0.079	7.39	0	258	273	0	0	19.8	0

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
NEW MADRID COUNTY PWSD 5	206	16.9	152	0.29	5.57	4.07	173	0.02	8.02	19.2	503	59	0	5.39	134	7.05
NEW MADRID PWS	179	51.6	11.5	0.15	1.85	9.84	5.47	0.18	7.63	30.6	229	169	0	9.48	46.5	12.1
NEW TRIBES MISSION INC	397	78	0	0	0	50.1	4.35	0.15	7.23	16	393	401	21.2	4.48	39.4	0
NEWBURG PWS	234	50.9	0	0.1	0.93	29.8	3.58	0.012	7.63	15.7	242	250	0	45.4	36.1	0
NEWTON CO PWSD 1	136	26.8	0	0.17	1.27	12.9	4.44	0	8.01	15.8	137	120	0	1.96	28.5	1.03
NIANGUA PWS	284	42.7	6.65	0	1.19	23.6	3.85	0	7.71	7.35	210	204	0	0	49.1	13.5
NIXA PWS	204	41.3	0	0	1.04	21.4	1.44	0	7.74	11	184	191	0	13.1	43.1	0
NORBORNE PWS	302	62.2	43	0.3	3.68	26.6	29.2	0	7.98	63.5	401	265	0	1.59	0	0
NORTH CENTRAL MO REGIONAL	113	34.7	21.8	0.14	5.19	9.06	8.34	0.068	7.81	16.7	169	124	11.3	12.5	0	0
NORTH HILLS ESTATES	294	51.4	0	0.34	2.44	24.2	7.47	0	7.9	25.1	256	228	0	3.29	116	2.39
NORTH KANSAS CITY PWS	87.1	17.5	29.4	0.24	7.02	18.6	44.2	0.037	8.89	125	307	120	0	1.57	0	2.25
NORTHERN HEIGHTS ESTATES S	294	63.5	0	0	0.81	38.4	2.19	0.15	7.43	14.3	289	317	0	1.99	13.8	1.22
NORWOOD PWS	215	46.3	0	0	1.65	26.1	1.58	0.16	7.87	0	199	219	0	1.29	7.29	0
OAK CREEK PARKWAY SUBD	248	54.7	0	0	1.3	25.9	2.58	0.014	7.64	14.8	235	243	0	7.65	7.49	0
OAK CREST ESTATES MOBILE HO	174	36.4	0	0	0.99	19.3	2.21	0	8.06	17.8	187	170	0	0	76.7	1.11
OAK GROVE TRAILER PARK	381	82.9	30.9	0	5.29	45.6	10	0	7.27	48.4	456	395	0	1.88	37.9	5.18
OAK GROVE VILLAGE PWS	201	29.7	9.01	0	0	18.9	4.86	0.65	8.21	15	184	152	0	16.1	9.12	0
OAK HILL FOREST SUBDIVISION	305	63.4	0	0	1	35.3	2.43	0	7.96	9.83	291	304	0	49.9	311	4.1
OAK HILL MHP	187	51.1	9.14	0	1.35	16.2	3.44	1.7	7.84	0	198	194	0	2.4	0	0
OAK RIDGE ACRES	306	67.2	0	0.16	1.62	38.7	5.04	0	7.32	40	325	327	0	4.17	44.9	2.09
OAK RIDGE ESTATES	289	60.3	0	0	1.55	35.4	2.44	0.098	7.56	11.1	281	296	0	2.93	0	0
OAK SHADOWS SUBDIVISION	347	70.7	17.4	0	1.07	45.5	4.14	0.31	7.5	11.2	354	364	0	10.9	0	0
OAK SHADOWS WATER ASSN	246	50.2	0	0	1.08	25.5	1.74	0.012	7.65	12.7	229	230	0	13.9	0	0
OAKBRIER ESTATES	217	38.8	0	0	0.57	22.7	2.35	0.082	7.65	0	178	190	0	1.34	0	0
OAKS HOMEOWNERS ASSN WAT	229	48.7	0	0	2.02	28.3	1.9	0	7.57	12.3	234	238	0	1.04	116	2.36
OAKWOOD HOMEOWNERS ASSN	348	58.5	0	0	0	33.9	3.16	0	7.76	5.84	286	286	0	117	0	0
OAKWOOD WATER ASSN	283	110	42.4	0.75	6.78	35.1	32.5	0.016	7.52	167	603	419	0	18.5	87.6	16.4
OCWC SPRING BRANCH WATER	334	70.6	0	0.13	0.85	53.6	2.43	0	7.49	50.6	411	432	0	3.67	0	7.04
ODESSA PWS	144	17.7	28	0.13	6.46	26.3	27.8	0.058	8.8	47.7	253	153	0	0	13.6	0
OFALLON PWS	291	21.7	52.6	0	11.9	43.2	139	0.11	7.73	58.1	378	174	0	11.6	0	2.05
OLD KINDERHOOK COMMUNITY	350	73.9	0	0	0.53	45.4	2.05	0	7.44	8.16	345	371	0	8.12	15.8	0
ORAN PWS	283	58.1	19.7	0.21	1.22	26.7	16.6	0.86	7.01	23.9	328	255	0	56.6	0	0
OREGON COUNTY PWSD 1	193	41.8	0	0	0.82	23.4	2.24	0.58	7.82	0	200	201	16.4	83.8	69.7	0

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
OREGON COUNTY PWSD 2	286	54.6	0	0	0.56	31.8	1.1	1	7.73	0	253	267	0	73.8	0	0
OREGON PWS	266	36.6	50.8	0.18	5.16	41.7	40.9	0	7.79	66.5	395	263	0	5	18.8	0
ORONOGO PWS	368	46.1	8.67	0.29	2.68	22.5	4.78	0	7.55	22.5	246	208	0	9.36	206	7.5
OSAGE BEACH EAST PWS	294	61.9	34.4	0	1.14	38.2	4.79	0	7.56	7.62	323	317	0	16.7	67.3	0
OSAGE BEACH HARBOR SUBD	330	71.7	0	0	0.91	43.6	2.62	0.021	7.29	5.41	335	359	0	2.88	65.2	0
OSAGE BEACH WEST PWS	294	59.4	6.77	1.08	0	33.7	5.5	0.016	7.66	8.67	271	287	0	11.1	32	9.92
OSAGE COUNTY PWSD 1	265	58.7	0	0.19	1.51	32.4	1.72	0	7.5	20.5	281	295	0	105	248	4.9
OSAGE COUNTY PWSD 2 NORTH	305	68.7	0	0	1.33	39.4	4.59	0.015	7.25	23	332	334	0	108	189	1.72
OSAGE COUNTY PWSD 2 SOUTH	322	70.5	0	0	1.01	37.5	2.85	0	7.28	23.9	319	366	0	144	46.7	1.1
OSAGE COUNTY PWSD 3	311	33.1	0	0	0.66	39.8	3.41	0	7.48	45.7	166	339	0	24.8	153	4.93
OSAGE COUNTY PWSD 4	186	42.6	0	0	0.73	22.3	1.62	0	7.8	15.9	209	198	0	60.2	271	4.03
OSAGE HIGHLANDS	324	66.9	0	0	0.6	39.6	2.23	0.017	7.48	0	319	330	0	61	12.1	0
OSAGE RIDGE APTS	354	28.4	39.3	0	0	32.5	69.7	0.64	7.13	0	388	205	0	12.7	0	0
OSBORN PWS	346	77.6	25.9	0.61	1.26	27.3	45.9	5.33	7.43	55.8	473	306	0	176	0	15.5
OSCEOLA PWS	207	67.7	41.5	0.26	4.3	26.3	23.6	0	7.64	54.4	347	262	0	9.99	164	4.41
OTTERVILLE PWS	264	58.8	0	0.19	2.4	27.1	7.38	0	7.75	17.6	254	258	0	8.59	145	5.17
OUR SLICE OF PARADISE	355	89.9	0	0	2.01	46.5	2.56	0.19	7.77	86.3	432	416	0	1.95	0	2.28
OVERLOOK SUBDIVISION	180	37.5	5.34	0.1	1.05	22.5	2.72	0	7.79	9.49	183	186	0	4.39	147	87.4
OWENSVILLE PWS	277	47	0	0.1	1.09	28.3	4.5	0	7.52	25.6	270	189	0	89.7	105	1.42
OZARK CORRECTIONAL CENTER	202	45.5	0	0	0	23	1.06	0.054	7.87	11.8	194	208	0	268	6.34	0
OZARK COUNTY PWSD 1	343	70.5	0	0	1.55	37.6	2.52	0	7.5	14.5	309	331	0	178	92.5	2.31
OZARK MOUNTAIN VILLAGE HO	275	69.9	0	0	2.02	36.1	1.03	0	7.45	53.5	336	323	0	19.8	371	20.3
OZARK PARK ESTATES	275	58	0	0	1.38	30.2	1.62	0	7.52	23.2	268	269	0	5.13	5.92	1.02
OZARK PWS	128	30.3	0	0	1.2	14.9	1.14	0	7.7	12	141	137	0	0	14.7	1.22
OZARK VILLA AT SHELL KNOB	330	62.6	5.92	0	1.22	31.5	3.46	0	7.57	16.9	275	286	0	6.57	206	2.51
PACIFIC PWS	318	63.9	7.85	0.7	0	35.8	9.88	0.87	7.38	20.4	353	320	0	26.3	0	0
PALACE LANE ESTATES	278	56.9	0	0	0.76	33.2	2.02	0.36	7.69	0	262	279	0	7.02	0	0
PALISADES VILLAGE	334	59.6	5.12	0.11	3.31	36.9	5.81	0.035	7.75	19.8	306	301	0	166	44.7	0
PALMYRA PWS	156	26.5	17	0.2	1.01	14	10.1	0.025	8.5	30.6	178	124	67.2	12.5	5.71	0
PARADISE ESTATES MHP	273	60.2	0	0.12	1.32	34.7	2.39	0.029	7.75	22.8	305	293	0	4.58	10.9	1.4
PARADISE LANDING/KIMBERLIN	239	45.5	19.3	0	1.62	25.1	11.9	0.019	7.51	5.58	253	217	0	15.5	3220	55.6
PARADISE MHP	310	76.8	60.6	0	1.34	42.5	27.4	2.05	7.35	27.8	450	367	105	6.06	18.7	0
PARADISE POINT RESORT LLC	274	62.1	5.99	0	1.73	31.6	1.77	0	7.62	18.8	273	285	0	0	91.9	7.87

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
PARK HILLS PWS	335	107	13.7	0.8	2.95	60.5	8.19	0.12	7.75	259	711	516	0	38.7	0	15.8
PARK PLACE MASTER ASSN	300	2.1	37.9	0.11	1.31	1.26	158	0	7.5	19.2	371	10.4	0	16.2	14.4	0
PARK PLACE MHP JOPLIN	161	38.5	0	0.11	1.98	16.5	2.88	0.025	7.87	15.3	171	164	0	3.55	15.2	2.02
PARKWOOD LAKE ESTATES	302	85.4	7.7	0.14	0.89	20	9.03	1.17	7.54	8.18	329	296	0	14.9	0	0
PARMA PWS	209	44.8	5.38	0.26	1.82	11.1	12.2	0.017	7.75	0	189	158	0	10.9	14.3	3.47
PATTERSON DUCK CLUB POA	308	78.7	0	0	2.7	41.2	2.11	0	7.65	67	368	366	0	255	31.9	2.83
PATTONSBURG PWS	285	78.7	10.1	0.15	1.57	10.1	12.5	0	7.94	18.8	298	238	0	23.1	0	0
PEACE OF MIND ESTATES	234	56.4	5.7	0	1.96	25.3	2.41	0	7.76	22.3	262	245	0	10.1	88.6	1.51
PEMBROOK VILLAGE SUBD	237	63.9	0	0.19	2.72	33.6	2.93	0	7.53	72.6	336	298	0	1.45	41.9	1.52
PEMISCOT COUNTY CON PWSD 1	363	3.23	20.4	0	1.73	2.07	22.7	0	7.72	5.63	131	10.2	0	12.1	65.3	2.29
PENINSULA SUBD	329	77.4	0	0	0.68	47.5	3.97	0.14	7.67	10.6	380	389	0	257	0	0
PERRY COUNTY PWSD 1	240	54.7	0	0.15	2.62	30.5	2.35	0.014	7.5	20.9	250	262	0	3.7	16.5	1.79
PERRYVILLE PWS	249	49.3	10.6	0.77	1.26	25.9	2.68	0.11	7.76	8.75	258	230	0	42.4	0	0
PEVELY FARM HOMEOWNERS AS	286	70.7	67.4	0.24	6.4	22.5	31.2	0.048	7.4	36.1	402	269	0	166	121	1.65
PEVELY PWS	253	56.1	0	0.12	1.11	28.8	1.89	0	7.39	27.3	262	259	0	15	59.8	2.42
PHELPS COUNTY PWSD 1	158	39.3	14.2	0	1.25	22.3	2.86	0.18	7.79	8.46	212	190	0	104	5.41	1.71
PHELPS COUNTY PWSD 2 NORTH	283	54.9	0	0	1.26	33.1	4.19	0	7.44	30.8	281	273	0	51.5	79.3	2.74
PHELPS COUNTY PWSD 2 SOUTH	245	57.3	0	0	0.8	36.3	2.62	0	7.6	72	292	303	0	34.1	336	19.8
PIEDMONT PWS	177	27.4	0	0.12	0	16.4	2.75	0.33	7.63	23	150	136	171	3.75	0	0
PIERCE CITY PWS	193	36.2	0	0	1.27	22.1	2.95	0.076	7.68	10.5	180	181	0	2.81	65.1	1.44
PILOT GROVE PWS	317	61.5	8.47	0.61	4.91	29.5	14.3	0	7.79	25	289	275	0	6.7	78	2.32
PILOT KNOB PWS	171	71.9	8.03	1.46	5.52	31.3	15.9	1.17	7.57	143	392	308	17.3	66.6	14.5	90.1
PILOT KNOB RURAL WD 1 DOE R	121	8.29	0	0	0	5.76	7.89	0	7.5	0	56	44.4	0	45.8	10.5	0
PINE FORD VILLAGE MHP	224	11.1	21.2	0.61	3.7	6.54	104	0.032	7.76	48.3	318	54.6	0	5.09	86.7	1.28
PINE TRAILS WATER CO	271	52.1	0	0	0.58	29.8	3.86	0.32	7.84	0	233	253	0	7.67	0	0
PINEVILLE PWS	187	27.3	31.5	0.61	1.94	12.5	25.1	0	7.4	19.6	196	120	0	25.9	0	0
PINNACLE SHORES SUBDIVISION	217	44.3	0	0.11	1.36	22.7	1.92	0	7.7	23.2	220	204	27	6.6	14	1.78
PIONEER POINT SUBD	236	42.1	5.17	0	1.07	22.3	3.7	0	7.94	17.5	189	197	0	8.17	25.8	0
PIPPINVILLE & OAK PARK OWNE	152	35.8	0	0.16	2.02	17	1.29	0	7.99	15.3	161	159	0	0	24.6	0
PLANTATION ESTATES	269	56.2	0	0	2.06	33.2	4.26	0	7.64	20.5	286	279	0	80.5	0	0
PLATTE COUNTY PWSD 4	249	105	48.3	0.16	0	10.2	20.7	3.93	7.13	35.9	421	304	0	9.96	38.1	9.7
PLATTSBURG PWS	106	32.3	12.9	0.25	3.73	5.55	6.73	0.6	7.76	14.2	148	104	13.9	3.75	0	0
PLEASANT HOPE PWS	173	36.9	0	0.1	0	19.2	1.49	0	7.72	11	177	171	0	4.79	484	5.74

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
PLEASANT OAK MHP	387	70.5	0	0.63	5.83	31.5	44.5	0	7.45	60.5	434	306	0	6.21	427	6.48
PLEASANT VALLEY ASSN 1	368	73.7	0	0	0	48.2	1.84	0.067	7.62	8.11	355	383	0	1.74	14.6	0
POINTE SEVEN CONDOMINIUMS	251	51.8	13.6	0	1.57	27.4	6.18	0	7.84	16.8	273	242	0	2.43	88	2.88
POM OSA HEIGHT SUBD	253	67	0	0.16	1.77	29.1	1.95	0	7.67	24.2	275	287	0	1	34.6	4.57
POPLAR BLUFF PWS	184	27.4	9.94	0.67	0	16.7	5.2	0.2	7.71	14.3	171	137	75.6	0	0	1.18
PORT PERRY SERVICE	251	45.9	0	0	0.54	28.2	2.78	0.13	7.93	0	224	231	0	76.2	0	0
PORTAGE DES SIOUX PWS	402	26.1	15.4	0.19	4.96	13.3	171	0.52	7.47	51.4	528	120	0	12.1	479	1480
PORTAGEVILLE PWS	224	58	13.6	1.18	2.08	13.9	12.5	0.074	7.47	17.6	263	202	0	98.4	82.5	6.45
POTOSI EAST	189	37.4	0	0.25	1.56	22.8	6.95	0	7.94	28.9	221	187	0	29.6	333	11
POTOSI PWS	191	45	6.45	0.31	1.89	25.7	9.37	0.02	7.69	29.4	236	218	0	91.1	16.9	11.8
PRAIRIE HEIGHTS SUBD	279	64.7	0	0.14	2.33	34.3	3.78	0.025	7.29	39.9	328	303	0	12.2	131	2.19
PRAIRIE HOME PWS	363	69.5	7.28	0.42	3	28.4	17.2	0	7.69	18.7	303	290	0	29.7	80.6	3.2
PRAIRIE VIEW ACRES SUBD	312	167	79.2	0.26	0	32.6	44.1	0	7.21	268	829	551	0	2.21	1550	124
PRINCETON PWS	85.7	16	31.8	0.15	1.79	9.31	20	0.41	8.72	42.5	185	78.3	0	0	0	0
PULASKI COUNTY PWSD 1	265	54	0	0	0.94	30.9	1.82	0.15	7.52	10.1	249	268	0	32.8	7.11	0
PULASKI COUNTY PWSD 2	225	48.1	0	0	0.82	33.2	1.86	0.71	7.42	5.39	256	235	0	67.3	13.2	0
PULASKI COUNTY PWSD 3	331	71.5	0	0	1.25	42.2	1.73	0	7.72	35.8	353	352	0	4.74	24	3.96
PURCELL PWS	186	52	8.23	0.31	2.14	19.4	10.3	0	7.59	16.4	191	210	0	41.2	68.8	2.58
PURDY PWS	249	42.1	6.24	0.82	1.03	19.5	4.55	0	7.67	20	191	185	0	53.1	34.3	1.25
PUXICO PWS	297	69.1	22.6	0.11	0.91	37.5	18.1	3.48	7.41	20.4	385	325	10.7	111	0	0
PWSD 2 OF HICKORY CO	246	64.3	0	0.13	1.58	31.6	2.93	0	7.48	15.5	247	236	0	0	839	9.46
PWSD 2 OF STONE COUNTY 265	316	61.8	0	0.12	1.34	32.8	1.57	0	7.48	15.6	283	289	0	22.1	5.39	0
QUAIL COVE SUBDIVISION	186	46.2	0	0	1.08	23.4	1.82	0	7.96	15.9	197	212	36.4	3.93	749	1.15
QUAIL CREEK MOBILE HOME PA	303	61.1	5.51	0.22	2.89	36.9	13.3	0.048	7.62	73.2	344	305	0	16.9	5.18	0
QUAIL RUN MHP	305	63	49.3	1.73	9.48	31.6	74	0	7.57	71.8	470	287	0	9.81	2200	23.2
QULIN PWS	227	19.5	141	0.52	6.56	5.4	163	0.036	8.03	17.5	483	70.9	0	102	216	6.49
RAINBOW HILLS	263	59.1	0	0	1.06	31.9	1.44	0.064	7.49	11.9	266	279	0	7.85	0	0
RAINTREE PLANTATION	325	68.7	0	0.11	3.9	36.7	4.89	0.055	7.4	35	339	323	0	10.2	26.4	0
RAVENWOOD PWS	162	49.5	42.5	0.15	1.04	11.6	26.7	0.026	8.13	82.6	321	171	141	0	0	0
RAY COUNTY CONS PWSD 2	233	53.2	20.6	0.17	6.53	23.7	7.64	0.019	7.56	53.6	302	230	0	151	0	0
RAYMONDVILLE PWS	201	44.8	0	0	1.23	24.9	2.15	1.68	7.74	7.76	220	216	0	53.1	13.1	0
RDE WATER COMPANY	240	48.3	7.35	0	1.49	23.2	3.35	1.05	7.7	9.74	235	216	0	2.13	0	0
RED CEDAR PT HOMEOWNERS A	319	83.9	0	0	2.77	42.7	2.21	0	7.72	68.8	382	385	0	115	19.3	2.5

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
RED OAK ESTATES	396	27.3	8.45	0.2	1.72	11.4	6.77	0.012	7.96	15.4	143	115	0	0	11.8	0
RED OAK SUBDIVISION	332	18.3	0	0	2.03	13.3	83	0.12	7.44	0	340	100	0	45.6	0	0
REDINGS MILL PWS	174	30.5	7.04	0.41	2.44	14.7	9.08	0	8	25.2	166	137	0	4.16	150	9.08
REEDS SPRING PWS	365	53	0	0	1.42	23.7	6.05	0.62	7.75	32.6	234	230	0	132	0	1.37
REPUBLIC PWS	181	34.5	0	0.39	1.46	16.2	1.9	0	7.79	15.1	153	153	0	15	18.4	0
REYNOLDS COUNTY PWSD 1	185	38.4	10.7	0	2.13	24.1	9.46	0.24	7.52	67.3	238	195	17.4	16.3	11.7	0
RHINELAND PWS	293	59.3	0	0.14	1.12	40.4	3.85	0.052	7.53	15.9	276	314	0	28.8	23.3	1.56
RICH HILL PWS	136	43.5	25.2	0.12	3.46	7.68	16.4	0.031	7.73	35.2	209	140	79.2	9.44	0	0
RICHLAND PWS	271	56.9	0	0	1.07	31.8	1.61	0.015	7.45	11.8	281	273	0	2.56	243	6.48
RICHMOND PWS	206	28.8	19.2	0.18	3.2	24.6	15.5	0.33	8.2	43.2	244	173	0	0	12.2	0
RIDGE CREEK WATER COMPANY	286	63.9	0	0	0.66	38	1.65	0.43	7.72	10.7	274	316	0	22.2	0	0
RIDGETOP WATERWORKS CORP	226	43.6	0	0	0.87	25.4	2.68	0.021	7.62	9.71	219	213	0	3.59	13.2	1.06
RIDGEVIEW ESTATES	252	55.5	8.99	0	0	32	2.22	2.12	7.5	8.94	281	270	0	10.3	0	0
RIPLEY COUNTY PWSD 1 EAST	203	46.9	5.29	0	0.54	24.4	2.29	0.77	7.78	9.5	227	206	0	18.7	1320	6.86
RIPLEY COUNTY PWSD 1 WEST	257	47.5	0	0	1.06	32.4	3.4	0.22	7.52	12.6	228	275	0	3.34	5.78	2.51
RIPLEY COUNTY PWSD 2	217	32.1	0	0	0.6	18.7	1.9	0.53	7.96	9.09	168	200	10.2	11.2	25	0
RISCO PWS	150	35.4	340	0.17	8.21	7.39	247	0.6	8.2	53.5	753	119	0	5.71	270	16.9
RIVERFORK RANCH ESTATES	188	30.9	5.2	0.34	2.02	15.6	4.75	0	7.78	17.2	161	141	0	6.71	41.5	1.27
RIVERVIEW NURSING CENTER	284	16.6	8.2	0.67	1.71	8.86	117	0.02	7.89	39.6	359	77.9	0	6.75	5.24	0
RIVIERA SOUTH WATER CORP	255	54.7	5.05	0.18	2.16	29.4	4.77	0	7.57	40.1	283	258	0	1.46	525	5.07
ROARING RIVER HOMEOWNERS	334	68.5	0	0	1.91	38.7	1.94	0	7.48	13.7	316	330	0	0	12.7	0
ROBYN POINT	343	67.9	0	0	0.76	40.4	2.39	0.094	7.39	6.37	320	336	0	1.72	0	0
ROCKAWAY BEACH PWS	260	44.6	0	0	0	24.9	2.05	0.15	7.71	22.1	208	214	0	103	5.28	0
ROCKPORT SUBDIVISION	288	58.8	23.1	0.96	6.35	28.4	43.6	0	8.66	63.9	382	264	0	2.67	104	2.06
ROCKRIDGE ESTATES SUBD	124	30.1	0	0	0	14.9	1.3	0	7.86	14.7	145	137	0	1.07	6.54	0
ROCKY TOP MOBILE HOME COU	213	52.3	6.01	0	1.54	20.1	1.89	0.74	7.61	10.3	226	213	0	2.63	0	27.1
ROGERSVILLE PWS	236	40.7	0	0	1.09	20.5	1.86	1.92	7.83	18.9	194	197	0	63.5	19	1.86
ROGUE CREEK UTILITIES	315	16.7	60.1	0.12	0	10.3	157	0.14	7.5	8.17	419	84.1	0	7.18	0	1.05
ROLLA PWS	262	58.6	0	0	1.07	35.5	3.11	0	7.61	30.5	257	265	0	7.5	46.1	318
ROLLIN ACRES SUBDIVISION	260	50.9	8.9	0	1.13	23.1	3.26	0.23	7.59	19.7	235	222	0	7.77	0	0
ROLLING MEADOWS	306	57.6	5.2	0	1.13	33.4	1.8	0.42	7.54	9.36	290	281	0	20.5	10.4	0
ROSEBUD PWS	183	28.7	0	0.12	0.79	20.5	1.76	0	7.9	22.7	201	174	0	58.6	0	0
ROUTE 66 HOMES	278	57.4	11.6	0	1.61	32	19	0.12	7.74	52.5	300	275	0	3.57	8.61	0

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
ROXBOROUGH MHP	398	77.7	30.3	0	0	47.7	9.91	0.67	7.22	19	427	390	14.7	8.15	12.9	4.13
ROY L UTILITIES	389	67.2	26.7	1.82	14.2	43.8	70.9	0.028	7.54	53.2	512	348	0	8.29	18.5	0
ROYAL LAKE ESTATES	362	143	41.9	1.21	0.51	9.47	26.2	2.77	7.19	17.1	486	396	0	3.26	75.6	0
RUSSELLVILLE PWS	390	76	0	0	1.46	38.2	5.37	0	7.52	26.2	329	347	0	4.54	129	10.1
S K & M WATER COUNTY INC	192	44.2	11.3	0	1.15	26	6.25	0.3	7.87	27.7	249	236	0	2.37	8.78	0
SALEM PWS	247	45.3	0	0	0.76	27.1	2.07	1.44	7.54	0	205	221	0	59.4	114	1.9
SALISBURY PWS	143	9.35	25.6	0.63	4.6	12.7	12.6	0.079	7.68	25.2	185	75.6	0	5.58	12.1	1.25
SARCOXIE PWS	191	25.3	0	0.42	1.59	12	4.59	0	8.04	17.6	126	113	0	1.19	14.6	0
SAVANNAH PWS	120	13.6	36.9	0.58	4.93	7.19	18.1	0.072	7.45	15	149	63.6	0	14.5	0	0
SCHOONER BAY LANDING SUBDI	237	51	5.64	0	1.07	27.1	1.79	0	7.81	9.58	220	239	0	12.3	14.7	0
SCOTSDALE SUBD	347	85	0	0	0	28.9	1.66	0.039	7.43	15.7	338	331	0	2.02	0	0
SCOTT CITY PWS	347	81.9	32.7	0.72	2.07	26.8	25.1	0	7.75	35.1	400	315	0	95	0	0
SCOTT COUNTY PWSD 4	157	30.2	8.76	0	1.22	5.29	7.49	0.021	7.79	23.6	138	97.2	0	6.47	5.46	0
SCOTTSDALE PARK PROPERTY O	348	82.9	14.5	0	1.53	47.8	4.31	0.012	7.46	14.7	364	404	0	108	89	0
SEDALIA PWS	261	53.6	0	0.48	1.86	22.5	7.79	0	7.63	14.2	230	240	0	0	92.3	3.18
SEDGEWICKVILLE PWS	290	57.2	8.23	0	0.6	28	3.53	1.4	7.72	0	253	258	13	177	5.5	0
SELIGMAN PWS	163	34.9	0	0	1.03	21.1	1.64	0.1	7.86	19.2	187	183	0	3	169	2.22
SENATH PWS	352	1.59	44.2	0.39	1.89	0	190	0	8.62	5.85	465	6.1	0	18.5	34.9	1.58
SENECA PWS	197	32.6	20.7	0.12	1.67	15.3	16.5	0	8.1	24.1	183	144	0	1.63	52.4	1.59
SERENITY BAY SUBD	352	71	0	0	0.8	43.6	2.91	0.045	7.49	10.2	335	357	0	11.1	13.4	0
SEVEN TRAILS WEST SUBD	442	58.3	5.74	0	1.17	32.7	5.41	0.11	7.68	5.7	260	280	0	2.77	0	0
SEYMOUR PWS	171	41.4	0	0	1.04	20.5	1.44	0.42	7.72	11.6	189	188	0	17.2	5.9	0
SHADY ACRES MHP	258	49.4	11.6	0.25	2.76	23.6	5.99	0.28	7.66	21.2	233	221	0	7.05	0	0
SHADY LANE SUBDIVISION	130	31.2	0	0.17	1.32	13.2	2.82	0	7.76	12	125	132	0	0	20.5	1.33
SHADY LANE TRAILER PARK	290	0	0	0	0	0	271	0	7.38	257	686	0	0	8.47	5.7	0
SHADY OAK MHP	250	53.2	7.16	0	1.07	30.6	1.6	0.75	7.7	5.77	245	259	0	3.83	6.04	0
SHALOM MOUNTAIN	283	62.8	0	0	0.77	38.2	2.54	0.041	7.53	16.7	305	314	0	29.4	20.9	5.78
SHELBINA PWS	212	48.6	27.3	0.7	6	5.1	11	0.32	7.36	5.78	189	142	27.4	3.2	8.01	0
SHELDON PWS	250	39	185	1.46	5.62	18.3	165	0	7.82	26.5	576	173	0	5.38	99.5	2.69
SHELL ROCK UTILITIES	269	53.6	0	0	1.02	28.8	1.79	0.035	7.75	15	274	252	0	3.75	298	4.49
SHERIDAN PWS	271	78.3	46.9	0.28	2.18	17.6	24.4	0.012	7.42	31.2	398	268	32.6	8.3	0	1.4
SHERWOOD SUBD OWNER ASSN	350	73.8	18.6	0	1.57	40.6	8.25	0.19	7.42	17	381	351	0	38.8	50.1	11.2
SHOW ME CHRISTIAN YOUTH HO	288	0	0	1.18	0	0	144	0	7.11	36	345	0	0	30.4	0	0

Inorganic Chemical Analyses

	mg/L (parts per million)												ug/L (parts per billion)			
SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
SIKESTON PWS	209	55.8	19.3	0.86	1.84	8.26	8.59	0.02	7.37	19.3	157	127	0	69.3	21.5	2.28
SILEX PWS	332	69.9	41.6	0.57	5.3	26.1	53.6	0.017	7.42	50.5	426	282	0	47.7	47.4	3.26
SILO RIDGE	234	42.4	0	0	0	23.3	2.58	0	7.71	10.5	209	202	0	15.1	184	1.87
SILVER BELL MOBILE HOME PAR	171	40.4	0	0	1.48	21.6	1.98	0	7.7	17.3	189	190	0	0	0	0
SKY BLUE WATER INC	128	29.3	25.9	0.6	2.08	13.8	20.4	0	7.96	16.2	188	130	0	11.4	205	1.86
SLATER PWS	150	24.5	23	0.8	1.84	11.4	13.2	0.08	7.89	15	146	108	0	1.35	30.6	1.09
SMITHTON PWS	312	76.8	0	0.13	1.99	31.3	5.72	0	7.49	16.7	312	360	20.9	31.7	197	24.7
SMITHVILLE PWS	128	27	11	0.2	3.4	4.58	5.73	0.58	7.84	10.2	139	86.3	0	7.01	0	0
SOUTH GREENFIELD PWS	207	34.3	5.28	0.16	1.5	15.8	4.99	0	7.9	17.4	169	151	0	22.4	57.5	1.14
SOUTH OAKS MHP	146	35.1	0	0	1.35	17.2	1.32	0	7.95	12.2	158	158	0	0	131	1.95
SOUTH SHORE WATER ASSN	290	67.1	0	0.11	1.08	36.5	5.33	0.18	7.52	43.7	328	318	0	3.9	0	0
SOUTH SIDE WATER ASSN	321	82	0	0.31	3.13	36.8	2.92	0	7.35	76.5	389	356	0	1.1	0	3.08
SOUTHERN HILLS WATER CO	291	59.9	0	0	1.22	28.2	8.15	0	7.53	17	290	279	0	44.2	32.8	5.24
SOUTHFIELD SUBDIVISION	326	59.5	58.3	1.71	8.1	28.5	68.6	0.057	7.85	74.2	465	266	0	12.1	16.9	0
SOUTHGATE SUBDIVISION	220	54.4	0	0.26	1.86	26.6	3.87	0	7.86	20.1	239	245	0	6.26	27.6	2.48
SOUTHPORT CONDOMINIUMS	275	56.5	0	0	1.02	29.6	2.01	0	7.68	18.9	251	263	0	12	120	4.21
SOUTHVIEW MHP & RV CAMP	352	70.1	10.3	0	1.26	42	4.31	0.5	7.4	41.7	390	348	0	1.88	0	1.67
SOUTHWAY TERRACE MHP	301	66.7	0	0	0.75	37.5	2.23	1.05	7.53	6.03	321	321	0	2.17	0	0
SOUTHWEST CITY PWS	151	26.5	15	1.02	1.91	7.68	4.81	0.81	7.91	20.3	225	112	0	8.99	108	0
SOUTHWEST RURAL WATER DIST	157	37.7	0	0	1.4	17.9	2	0	7.88	0	168	161	0	65	16.8	2.22
SOUTHWOOD ACRES SUBD	214	47.5	0	0.26	1.53	22.5	4.24	0	7.63	14	222	211	0	47.7	68.4	1.25
SPARTA MHP	192	46.7	0	0	1.36	22.5	1.43	0.96	7.76	10.5	201	209	0	1.42	0	0
SPARTA PWS	177	37.8	0	0	0	18.4	1.88	0.18	7.85	20.4	161	170	12.5	47.5	0	0
SPOKANE HIGHLANDS	212	44.2	0	0	1.7	23.6	2.03	0	7.62	14.8	218	208	0	4.94	86.2	4.73
SPRING MEADOWS MHP	192	44.9	0	0	0	24.1	1.43	0	7.68	17.8	208	211	0	1.01	5.71	0
SPRINGFIELD PWS	214	60.9	16	0.58	1.84	10.6	9.76	0.92	7.27	11.2	238	196	27.2	1.07	0	0
ST CHARLES COUNTY PWSD 2	125	62.2	149	0.6	3.34	19.7	42.8	0	7.73	46.1	309	329	0	2.27	238	0
ST CHARLES COUNTY PWSD 2 AU	327	64.5	5.48	0.1	1.3	33.5	4.77	0.28	7.37	15.9	302	299	0	31.1	0	0
ST CHARLES COUNTY PWSD 2 DU	336	58.8	7.06	0.2	1.64	32	6.9	0.21	7.53	14.2	265	279	0	10.1	12.2	1.2
ST CHARLES COUNTY PWSD 2 HI	297	61.6	32.6	1.27	5.93	27.1	42.4	0.038	8.05	74.8	290	265	0	2.49	146	2.24
ST CHARLES COUNTY PWSD 2 NO	322	53.7	39.8	1.61	6.56	26.1	64.3	0.023	7.54	63.1	411	242	0	2.96	68.3	2
ST CHARLES COUNTY PWSD 2 SU	318	64.1	17	0.88	6.87	28.3	24.5	0.018	7.66	41.7	348	277	0	7.56	44.9	10.3
ST CHARLES COUNTY PWSD 2 W	368	64.7	50.8	1.42	8.11	33	71.7	0.048	7.39	87.1	506	293	0	102	43.9	1.59

Inorganic Chemical Analyses

	mg/L (parts per million)												ug/L (parts per billion)			
SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
ST CHARLES PWS	73.9	25.6	16.3	0.5	2.89	14.6	13.6	0	9.11	58.8	186	124	0	0	5.31	1.64
ST CHARLES PWSD 2 FORISTELL	367	61.3	48	1.46	8.14	29.7	60.1	0.052	7.14	61.4	446	275	0	4.29	143	3.75
ST CLAIR PWS	192	44.6	19.3	0.24	1.08	26.1	12	0.02	7.76	35.1	253	212	0	80.4	5.66	2.58
ST ELIZABETH PWS	277	59.9	0	0	0.91	34.1	2.55	0.45	7.72	0	269	290	0	93.7	11.1	0
ST FRANCOIS COUNTY PWSD 1	291	75.2	8.32	0.13	1.78	51.5	9	0.43	7.5	93.9	449	400	0	3.12	29.3	12.1
ST FRANCOIS COUNTY PWSD 2	293	63.1	0	0	1.46	50.5	3.58	0	7.48	34.9	352	434	0	8.08	11.6	24.8
ST JAMES PWS	245	57.2	0	0	1.37	33.5	4.35	0	7.67	56.3	312	281	0	0	760	5.43
ST LOUIS CITY PWS	41.7	22	21	0.54	6.18	14.5	45.3	2.2	9.55	145	299	121	3.82	3.128	0	0.35
ST MARYS SEMINARY	130	30.6	7.63	0.55	1.82	16	2.97	0.68	7.86	9.28	157	142	0	172	6.2	0
ST PAUL PWS	450	64	64.7	1.84	9.65	28.5	96	0.036	7.59	99.5	545	277	0	122	32.3	1.4
ST PETERS PWS	79.5	32.8	154	0.33	3.38	22.4	85.2	0.062	8.16	58.4	418	174	0	2.9	0	4.73
ST ROBERT PWS	276	50.9	23.2	0	1.3	34.5	1.51	0.39	7.72	12.5	246	292	0	1.53	0	1.27
ST TROPEZ SUBDIVISION	404	77.5	0	0	0.5	46.6	3.76	0.1	7.21	10.7	382	385	0	7.68	0	0
STARRLITE VILLAGE 4TH ADDITI	167	53.1	0	0.26	1.68	25.6	0	0	7.94	17.5	179	238	0	170	96.7	0
STARRVILLE PARK	180	45.2	0	0.12	1.36	23.2	1.41	0	7.9	25	197	208	0	1.52	7.21	0
STATELY MANSION MOBILE VILL	273	56.2	0	0	1.04	33	2.83	0	7.72	19.8	264	276	0	12.4	54.2	1.65
STE GENEVIEVE COUNTY PWSD 1	298	66.4	0	0	0.56	41.5	3.23	0.094	7.44	7.66	281	298	0	97.2	0	0
STE GENEVIEVE COUNTY PWSD 1	299	61.2	0	0	0.89	43.4	2.52	0.4	7.57	9.33	319	332	0	24	0	0
STE GENEVIEVE PWS	360	132	91.7	0.16	7.98	24.8	41.2	0.82	7.03	54.2	672	432	0	2.75	30	256
STEELE PWS	153	6.55	0	0	4.73	2.13	30.3	0.15	7.67	12.3	299	25.1	0	8.9	14.3	12.7
STEELVILLE PWS	218	41.2	0	0	0.89	26.2	2.23	0.073	7.84	11.7	201	195	0	131	0	0
STELLA PWS	148	28.5	0	0.19	1.2	13.4	3.86	0	8.01	13.3	138	126	0	3.05	102	1.22
STERETT CREEK VILLAGE	287	58.3	0	0	1.01	33.7	2.55	0.2	7.59	12	267	277	0	1.07	11.4	0
STOCKTON HILLS WATER CO	244	63.3	5.31	0.12	1.05	23.6	3.98	0	7.63	15.2	253	255	0	23.3	31.6	2.28
STOCKTON PWS	208	46.5	23.7	0.17	4	21.2	31.2	0	7.53	26.5	270	203	0	42	10.1	1.09
STODDARD COUNTY PWSD 1	249	56.8	115	0.56	6.05	17.6	78.8	0	7.34	19.2	415	214	0	66.8	52.1	3.59
STODDARD COUNTY PWSD 2	733	77.8	38.7	0.13	1.29	39.8	26.9	1.99	7.31	28.7	452	358	0	7.88	14.9	0
STONE COUNTY PWSD 1	238	49.6	0	0	1.17	27.3	2.8	0.11	7.46	11.3	225	235	0	41.5	0	0
STONEBRIDGE WEST SUBD	317	56.9	0	0	1.09	27	2.99	0.012	7.5	12.4	259	253	0	16.4	718	4.98
STONECROFT CONFERENCE CEN	271	58.2	0	0	1.89	29.7	1.22	0	7.6	13.1	264	268	0	0	9.45	0
STONES MHP	165	39.9	0	0	1.55	19.9	1.66	0	7.76	14.6	174	182	0	1.91	130	2.42
STONEY RIDGE VILLAGE	264	54.5	0	0.76	4.37	26.5	11.3	0	7.61	23.1	279	245	0	5.58	2230	0
STOTTS CITY PWS	120	32.2	0	0	1	14.9	2.08	0	7.95	27.7	153	142	0	0	84.1	1.26

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
STOVER PWS	247	46.6	7.99	0	1.09	30.3	5.87	0.15	7.56	12.5	264	269	0	34.8	0	0
STRAFFORD PWS	167	30.7	0	0	1.27	14.7	2.84	0	7.98	23.4	150	137	0	56.9	9.07	0
SUBURBAN ACRES MOBILE HOM	140	35	0	0	1.23	16.4	1.6	0	7.9	18.4	158	155	0	2.64	0	0
SUGAR TREE CLUB	322	62.8	0	0.11	0.61	37.5	2.19	0	7.7	11.3	301	311	0	124	71.8	0
SULLIVAN PWS	169	32.3	0	0	0	18.4	3.61	0.3	7.66	19.7	179	170	35.9	321	0	0
SUMMER PLACE ON THE LAKE	235	62	46.5	0.18	1.66	32.5	18.3	0	7.52	13.7	297	289	0	0	71.9	8.14
SUMMER SET UTILITY CO	327	71.6	0	0	0	40.5	2.96	0	7.22	46.7	352	346	0	5.77	185	4.01
SUMMERHAVEN SUBDIVISION	352	109	10.4	0.93	5.77	48.1	32.1	0.33	7.4	121	561	427	0	42.4	16.4	18.9
SUMMERSVILLE PWS	231	40.4	0	0	0.88	26.9	1.06	0.3	7.97	0	197	212	0	18.6	12.7	0
SUNDOWN WATER SYSTEM INC	324	67.3	0	0	1.3	38.8	1.97	0.083	7.49	9.66	316	328	0	2.8	0	0
SUNRISE BEACH VILLAGE OF PW	273	54.6	0	0	1.14	33.6	3.44	0.024	7.92	10.9	265	275	0	214	17.4	0
SUNRISE LAKES SUBD	215	65	17.9	0	0	45.1	9.3	0.017	7.8	11.5	197	178	0	3.91	12	0
SUNSET HEIGHTS 2ND ADDITION	179	38	0	0.17	1.89	17.3	3.88	0.023	7.71	17.4	190	166	0	2.6	64	7.43
SUNSET HEIGHTS SUBD WELL 2 B	159	32.6	0	0.12	1.65	16	2.4	0	7.72	14.8	170	147	0	2.08	10.3	0
SUNSET MHP	395	96.8	13.6	0	0.99	14.6	9.1	1.98	7.2	17.7	326	302	0	26.9	10.4	0
SUNSET MHP	238	60.7	9.47	0	1.56	35	9.08	3.93	7.75	25.1	299	296	0	10	0	0
SUNSHINE ESTATES	234	45.3	0	0	0	26.8	2.85	0	7.72	7.07	226	223	0	0	359	5.66
SUSSEX PARK SUBD	191	48.3	10.9	0.18	3.36	21.1	4.93	0	7.35	16.3	229	207	0	4.88	43.6	1.95
SWEETWATER BEACH SUBD	259	55.6	0	0	0	30.1	1.14	0.095	7.59	12	267	263	0	8.07	0	0
SYCAMORE GREEN ACRES MHP	255	54.5	0	0.11	2.78	28.9	2.89	0.054	7.52	20	259	255	0	2.88	37.1	0
SYCAMORE LANDING ASSN	285	55.4	7.01	0.1	1.71	31	2.49	0	7.65	18.5	279	266	0	32.7	57.2	2.16
SYCAMORE RIDGE SUBDIVISION	260	51.8	0	0	1.34	28.8	2.46	0.21	7.65	18.8	245	248	0	63.3	9.5	0
SYCAMORE SPRINGS	272	58.8	0	0.17	2.64	29.3	4.63	0	7.57	20.9	268	267	0	1.57	398	2.39
SYCAMORE VALLEY SUBD	272	68.6	0	0.18	1.69	37.4	3.02	0	7.64	33.6	318	325	0	7.08	62.4	1.94
SYLVAN BAY SUBDIVISION	3120	71.9	104	0.12	1.05	42.1	49.7	0.057	7.86	7.47	514	353	0	2.21	40	1.68
SYLVAN MANOR SUBD	300	56.6	6.43	0	1.16	33.7	4.78	0.11	7.39	50.3	338	280	0	7.2	5.72	0
SYRACUSE PWS	325	66.9	0	0.14	1.19	38	4.31	0	7.51	16.8	318	332	0	119	82.7	4.03
TABLE ROCK ESTATES SUBD	200	44.7	0	0	1	24.4	1.87	0	7.78	31	218	210	0	5.55	36.8	0
TABLE ROCK HEIGHTS HOME OW	264	59	0	0	2.06	29.2	1.72	0	7.7	14.2	256	268	0	3.88	8.69	1.59
TABLE ROCK RETIREMENT VILL	219	47.9	0	0	0	23	1.62	0.13	7.8	10.5	228	214	0	3.88	10.7	0
TALL OAKS MHP	197	41.6	12.8	0	2.11	23.6	5.5	2.22	7.82	0	211	201	0	9.63	0	0
TANEY COUNTY PWSD #2 - CEDA	293	62.4	0	0	1.56	36.1	1.49	0.16	7.71	17.9	278	304	21.2	56.2	40	0
TANEY COUNTY PWSD 1	347	70.9	0	0	1.06	43.6	1.64	0.035	7.26	14.2	333	357	21.8	13.2	9.2	0

Inorganic Chemical Analyses

	mg/L (parts per million)												ug/L (parts per billion)			
SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
TANEY COUNTY PWSD 2	259	53	0	0.11	1.68	32.1	1.37	0.068	7.65	14.2	248	269	0	9.03	21.2	1.07
TANEY COUNTY PWSD 3	1320	48.6	6.37	0	1.19	22.5	3.72	0.012	7.68	14.3	243	227	0	29.3	22	0
TANEY COUNTY WATER LLC LA	338	64.8	0	0	0	38.4	2.37	0.12	7.67	5.78	313	320	0	11.8	0	0
TANEY COUNTY WATER LLC VE	287	73.2	31.1	0	1.26	35.4	1.37	4.84	7.56	19.2	278	380	0	2.23	0	0
TANEYCOMO HIGHLANDS SUBD	279	61.4	0	0	2.13	32.5	1.73	0	7.8	27.2	311	287	0	2.73	31.7	1.41
TANGLEWOOD MOBILE COURT	262	69.3	0	0	1.76	42.6	5.12	0.027	7.55	98.3	381	348	0	5.62	122	4.8
TARA OAKS MANOR ASSN	339	18.3	18.2	2.1	8.27	11.9	138	0.032	7.67	89.9	483	94.7	0	12	27.9	0
TARA VALLEY WATER ASSN	334	58.9	58.5	1.73	7.91	28.4	67.9	0	7.74	74.8	472	264	0	24.6	16.5	0
TERRE DU LAC	297	48.7	0	0.14	1.76	33.7	4.56	0	7.82	21.9	261	260	0	4.01	56.7	0
TEXAS COUNTY PWSD 1	246	34.4	0	0	0.81	20	1.02	0.028	7.66	7.28	241	168	10.2	16.6	26.9	0
TEXAS COUNTY PWSD 2	232	49.9	0	0	0.97	24.3	2.07	0.42	7.89	0	217	239	0	1.16	9.01	0
TEXAS COUNTY PWSD 3	177	39.9	0	0	0.9	25.6	1.23	0.049	7.76	0	176	224	0	2.72	0	28.9
TEXAS COUNTY PWSD 4	274	53.9	0	0	1.19	31.5	1.7	0.055	7.75	6.72	239	264	0	1.58	7.5	0
THAYER PWS	365	63.6	5.48	0	0.94	37.9	0.76	0.71	7.73	0	330	315	0	0	0	0
THE FALLS CONDOMINIUMS	322	0	0	0	2.53	0	145	0.16	7.29	0	369	0	0	6.05	0	0
THE KNOLLS	321	68.1	0	0	0.87	40.9	3.5	0.027	7.44	8.92	321	338	0	141	0	0
THE LANDING SUBDIVISION	163	37.4	0	0	0	18.9	1.48	0	7.82	16.1	178	171	0	6.5	57.3	1.27
THE LEGACY RANCH								0.033								
THE MISSING WELL	223	76.7	8.28	0.48	9.03	38.6	17.5	0	7.56	96.2	359	350	0	0	7.77	2.92
THE WILLOWS UTILITY COMPAN	190	37.1	0	0.16	1.64	17.4	3.4	0	7.79	12.2	167	164	0	7.39	36.2	1.87
TIMBER RIDGE ESTATES	383	30.5	217	4.4	10	15.7	286	0.027	7.72	216	1040	141	0	10.3	22.8	0
TIMBERLAKE MASTER ASSN INC	227	44.3	7.87	0.28	2.68	23.9	12.1	0	7.95	12.1	238	209	0	13.8	93.4	2.52
TIMBERLOST MHP	219	86.5	10.5	0	1.4	1.79	4.21	1.27	7.24	9.34	252	223	24.4	10.6	13.2	0
TIPTON PWS	303	64.3	0	0.34	2.14	32.3	8.8	0	7.5	18.3	284	290	0	4.67	9.54	9.49
TONYS POINT	395	87.8	17.4	0	0	53	6.18	0.95	7.37	22.4	437	437	0	1.91	0	0
TOWN & COUNTRY MHP	228	94	16.7	0	0	1.59	4.28	1.62	7.29	7.88	288	243	0	6.34	9.26	0
TOWN OF CHARMWOOD	202	46.6	0	0	2.38	25.8	3.67	0.98	7.88	5.7	212	223	0	0	5.89	0
TOWN OF MARTIN	157	43.4	0	0.24	1.46	19.2	3.39	0	7.73	24.7	192	187	0	7.83	0	0
TREEHOUSE CONDOMINIUMS	311	62.4	0	0	1.17	27.5	2.84	0.022	7.58	16.2	266	269	0	8.62	16.8	0
TRENTON MUNICIPAL UTILITIES	163	17	30	0.62	4.41	3.96	26.7	0.097	8.83	27.8	153	58.8	49.3	1.55	27.1	1.03
TRI COUNTY WATER AUTHORITY	76.5	16.8	26.3	0.17	6.35	15.8	46.3	0.54	8.23	112	262	107	0	2.83	9.98	4.11
TROY PWS	310	67.9	137	1.64	15.3	31.2	103	0.042	7.38	178	614	304	0	65.5	0	0
TRUESDALE PWS	314	56	46.6	1.43	6.86	27.3	61.2	0.024	7.69	58	440	252	0	12	81.4	3.66

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
TT SEWER	350	70.7	0	0	0.71	43.3	2.32	0.16	7.65	0	340	355	0	1.41	132	1.62
TUK LLC	291	70.1	6.38	0.32	1.5	27.7	3.62	0	7.44	21.4	253	289	0	10.8	157	1.7
TURNER ESTATES SUBD	234	51.1	0	0	1.15	26.1	1.76	0.011	8.04	13.3	222	235	0	8.43	17.1	0
TUSCANY CONDOMINIUMS	349	72.5	5.56	0	0.94	43.3	5.97	0.078	7.7	9.59	347	359	0	8.62	0	0
TWILITE HOME SITES	285	65.4	5.85	0	1.25	35.8	1.18	0	7.46	29.3	336	311	0	0	584	1.58
TWIN ISLAND ESTATES	259	54.5	0	0	1.12	28.9	1.92	0	7.5	13.2	255	254	0	17.7	176	1.71
TWIN ISLAND HGTS HOME OWNE	238	0	5.66	0	0	0	123	0	7.73	13.8	281	0	0	5.73	0	0
TWIN LAKES MOBILE HOME AND	393	91.8	0	0	2.29	52.3	6.6	0	7.04	53.6	422	445	0	95.2	0	0
TWIN OAKS HARBOR	223	61.4	0	0.46	3.81	26.6	8.74	0	7.63	38.6	269	263	0	0	407	3.32
TWIN RIDGES PARK INC	471	47	11.9	0.12	2.31	21.6	7.04	0.36	7.89	14.3	221	206	0	7.42	7.65	0
TWIN RIVERS SUBD	293	60.6	9.72	0	1.61	32	3.72	0	7.72	16.3	276	283	0	4.69	19.7	1.59
UNION PWS	192	59	7.01	0	0	36.5	9.14	0.28	7.59	7.84	344	195	0	5.89	52.7	1.24
UNIONVILLE PWS	125	49	15.5	0.69	6.13	6.76	23.3	0.036	7.52	70.1	244	150	61.2	3.2	0	0
UNITY VILLAGE	117	47.5	198	0.12	3.04	7.3	94.6	0.23	7.68	36.7	470	149	91	4.22	0	0
UNIVERSITY OF MISSOURI COLU	287	57.6	30.5	1.21	7.3	25.3	49.7	0	7.39	31.4	363	251	0	99.1	0	1.33
UPPER BEND ROAD SUBDIVISION	206	64.5	8.31	0.14	1.73	13.8	5.71	0.2	7.69	10.2	240	218	0	4.87	18.2	3.49
URBANA PWS	289	55.2	0	0	1.19	34.6	3.49	0	7.56	38.2	256	303	0	11.2	657	2.32
USACE MINGO JOB CORPS CCC	289	41.4	9.67	0.15	2.5	32.7	44.2	1.25	7.43	15.4	333	238	0	141	0	2.03
VALLE ACRES MHP	898	69	0	0.52	1.53	29.1	2.81	0.011	7.9	14.1	711	292	0	2.98	0	1.68
VALLE LAKE SUBD	424	77.3	10.4	0	0	47.1	7.51	0.18	7.32	35.3	404	387	0	8.51	16.7	0
VALLEY LAKE ESTATES	334	65.9	13.2	1.49	8.87	29.6	34.7	0.049	7.44	57.8	407	286	0	4.98	254	2.75
VALLEY WOODS SUBDIVISION	175	41.9	0	0.13	1.64	21.2	1.12	0	7.73	14.4	189	192	0	0	35.8	1.15
VAN BUREN PWS	253	51.8	9.93	0	1.4	32.5	5.38	0.95	7.65	0	266	263	0	234	0	0
VANDALIA PWS	64.6	40.9	12.7	0.34	4.09	4.3	4.57	0.89	7.61	55.7	175	120	200	2.94	0	0
VANDUSER PWS	178	62.2	20	0.21	1.14	16.8	7.08	0	7.5	35.8	314	224	0	2.09	2070	339
VAUGHN TRAILER PARK	210	47.3	0	0	1.19	23.9	2.5	0.9	7.74	9.95	218	217	0	1.24	0	0
VERNON COUNTY CONS PWSD 1	253	44.9	185	0.96	6.13	21.2	145	0.013	7.66	25	513	199	0	6.14	0	0
VERNON COUNTY PWSD 2	216	39.8	163	0.56	5.51	18.8	99.5	0	7.66	22	435	177	0	10.1	37.2	1.13
VERSAILLES PWS	395	101	7.92	0.13	1.08	62.2	6.58	0	7.54	175	505	508	0	23.6	1740	32.2
VIBURNUM PWS	194	36.3	5.09	0.46	1.83	21.4	9.77	0	7.74	22	195	176	0	16.5	148	1.7
VIENNA PWS	322	60.4	11.8	0	0.93	40.3	6.95	0.063	8.16	25.3	326	317	0	8.08	15.5	4.71
VILLAGE GREENS	201	42.3	0	0	1.19	24.4	2.65	0.4	7.77	9.7	213	206	0	1.74	14.5	0
VILLAGE OF CONEY ISLAND	223	62.9	0	0.18	0	31.6	1.77	0	7.97	23.9	237	287	0	2.6	14.6	0

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
VILLAGE OF MC CORD BEND	178	25.3	6.02	0	0	14.3	3.87	0	8.06	11.6	140	122	0	38.5	160	1.63
VILLAGE OF PRESTON WATER DE	261	56.5	0	0.19	2.52	29.7	3.69	0.016	8.2	17.5	260	263	0	5.74	142	3.21
VILLAGE OF UMBER VIEW HEIGH	206	44.1	13	0.24	3.38	20.8	10.4	0.018	7.76	28.3	251	196	0	53	35.2	1.99
VILLAGE OF WEST SULLIVAN PW	158	35.4	0	0	0	23.1	1.88	0.11	8.11	10.3	164	184	0	0	196	5.1
W E SEARS YOUTH CENTER	255	44.3	5.82	0	0	25.3	4.4	0.087	7.89	0	223	215	0	84.9	27.3	0
WADSWORTH PARK UNIT 4 AND	177	42.2	0	0.13	1.78	22.2	2.04	0	7.62	22.8	210	197	0	1.12	42	1.08
WALKER HILL MHP	311	90.6	9.17	0	2.46	52.9	9.44	0	7.46	124	492	444	0	21.7	164	2.7
WALKER MOBILE HOME PARK	267	62.9	0	0.18	4.35	32.4	1.58	0	7.45	19.4	276	290	0	5.72	75.7	2.07
WALKER PWS	228	61.4	359	0.62	9.25	29.6	255	0	8.04	38	826	275	0	22.3	129	2.94
WALL EYE HAVEN MHP	316	61.6	5.89	0	1.06	36.5	1.93	1.21	7.58	10.5	310	304	0	2.55	6.59	0
WALNUT GROVE MHP	119	10.1	12.8	0.18	0	3.83	45.4	0.94	7.07	12.7	172	41	0	2.72	27.5	0
WALNUT GROVE PWS	155	34.1	0	0.11	0	17.5	1.9	0	7.91	13.8	166	157	0	35.8	296	2.58
WARDELL PWS	279	4.74	29.1	0.22	2.82	0.72	142	0.033	8.41	7.46	370	14.8	0	103	52.8	5.41
WARE LAKE SUBD	317	63.4	0	0	1.5	38.8	3.83	0.3	7.44	29.1	334	318	0	14.5	5.22	0
WARREN WOODS SUBD	345	85.2	15.2	0.13	0	25.6	7.89	0.029	7.42	22.8	338	318	0	1.73	0	1.17
WARRENS OAKLAND PARK								0.028						5.05		
WARRENTON PWS	311	60.6	55.1	1.19	8.7	28	53.9	0.028	7.32	77.3	402	266	0	70.5	90	3.88
WARSAW PWS	281	65.5	5.34	0.58	2.22	32.7	4.49	0	7.67	40.8	297	298	0	28.2	31.2	2.18
WASHBURN PWS	147	23.4	5	0	0	10.9	2.1	0	8.07	14	120	94.6	0	4.54	19.9	1.96
WASHINGTON COUNTY PWSD 2	235	48.1	8	0.11	0.64	28.5	6.33	0.15	7.71	0	236	237	76.4	48.3	88.6	0
WASHINGTON PWS	298	47.5	0	0	1.33	32.3	3.7	0	7.65	14.3	252	252	0	7.56	0	0
WATKINS SUBDIVISION	133	27.2	0	0	0	16.1	1.47	0.07	7.97	0	131	134	0	0	5.9	0
WAYNE & BUTLER COUNTY PWS	236	45.7	0	0	0	26.5	1.95	0.019	7.59	11.3	212	223	0	35.8	0	0
WAYNE COUNTY PWSD 2	255	46.4	5.74	0	0	29	4.41	0.084	7.78	0	222	235	74.9	9.98	21.8	0
WAYNESVILLE PWS	276	63.5	0	0	0.72	30.9	1.29	0.11	7.6	20	276	263	0	73.9	16	0
WEAUBLEAU PWS	351	54.2	7.53	0.19	2.37	22.3	10.5	0	7.81	15.8	243	227	0	18.8	48	3.17
WEBB CITY PWS	137	35.4	7.41	0.19	1.96	16.5	7.35	0.012	7.88	31.7	195	164	0	6.93	18	1.05
WELDON SPRING HEIGHTS VILLA	269	59.3	0	1.14	7.85	29.2	14.3	0	7.74	37.4	253	268	0	1.48	12.5	1.92
WEST PLAINS PWS	257	49.3	6.36	0	2.34	28.6	2.29	1.3	7.36	9.26	240	241	28.8	64.7	0	0
WESTLAKE MEADOWS SUBDIVISI	242	0	207	0.58	1.88	0	258	0.054	7.69	64.4	670	0	0	10.2	0	0
WESTMIER SUBDIVISION	305	69.3	113	1.81	8.6	29.9	117	0.11	7.54	114	653	296	0	6.78	301	11.7
WESTON PWS	173	31.7	30.4	0.15	4	11.9	18.1	0.031	8.17	36.4	221	128	0	6.22	9.2	0
WESTVIEW MOBILE HOME PARK	268	54.4	5.78	0	1.07	32	5.52	2.59	7.61	11.2	269	268	0	1.64	0	0

Inorganic Chemical Analyses

SUPPLYNAME	Alk	Ca	Cl	F	K	Mg	Na	NO3	pH	SO4	TDS	TH	Al	Cu	Fe	Mn
	mg/L (parts per million)												ug/L (parts per billion)			
WHEATLAND PWS	281	51.9	6.14	0.11	0	21.8	5.11	0	7.71	8.3	228	219	0	17.9	77.8	6.96
WHEATON PWS	212	48.9	0	0	1.19	18.5	3.03	0	7.73	25.5	218	198	0	0	7.13	1.56
WHISPERING HILLS SUBD	316	71.7	0	0	0.62	47.4	2.4	1.01	7.62	6.51	350	357	0	28.4	6.67	0
WHISPERING HILLS SUBDIVISION	252	51.9	5.57	0	0.5	29	3.12	0.34	7.44	0	244	249	0	15.9	0	0
WHITE EAGLE WOODS MHP	247	52.1	0	0.14	1.21	27.9	1.38	0	7.67	13.2	233	245	0	1.46	23.2	0
WHITE PINE VILLAGE	196	48	5.67	0.12	2.22	22.1	1.56	0.014	7.76	16.8	204	211	0	6.06	0	0
WHITEMAN AIR BASE	136	13.7	34.1	0.56	4.09	16.5	39.5	0.026	7.9	49.9	198	102	33	19.7	0	0
WHITESIDE HIDDEN ACRES	252	60.7	0	0.19	2.46	29.3	3.48	0.24	7.53	18	255	272	0	0	131	2.26
WHITEWATER/ALLENVILLE PWS	297	63.8	13.5	0.11	0	35	7.83	4.12	7.52	8.42	316	303	0	8.44	0	0
WILDEN HEIGHTS HOA	168	46.6	9.65	0	2.33	21.7	2.45	0	7.71	33.7	227	206	0	30.1	279	3.39
WILDERNESS PINEWOOD WATER	295	64.9	5.5	0	1.21	37.4	2.18	0.58	7.45	9.33	297	316	0	10.1	0	0
WILDFLOWER HOA	240	50.6	5.09	0.15	1.69	26.7	2.81	0.011	7.71	12.3	222	236	0	91.3	235	2.18
WILDWOOD LOT OWNERS ASSN	326	65.9	29	1.34	12	31.6	64.3	0	7.7	98	509	295	0	95.6	153	1.72
WILLARD PWS	173	34.6	0	0	1.21	16.6	0	0	7.7	14.5	166	155	0	2.63	0	1.84
WILLIAMSVILLE PWS	178	27.4	0	0	0.9	16.2	0.99	0.5	7.43	0	137	135	0	63.1	10.6	0
WILLOW SPRINGS PWS	275	51.8	0	0	1.18	30.3	2.71	0.19	7.58	0	239	254	0	2.5	0	0
WINDSOR APARTMENTS	235	51.8	0	0	0	30.3	2.04	0.076	7.86	13.4	237	254	0	2.46	13.5	0
WINDSOR PWS	302	70.5	6.36	0.61	4.04	30.8	22.3	0	7.54	66.8	366	303	0	2.57	51.2	7.41
WINDWOOD ESTATES SUBD	296	94.5	103	0.32	4.33	36.1	31.9	0	7.37	36.5	530	385	0	242	340	7.33
WINEGARS TEAL BEND SUBD	230	62.5	10.7	0.54	4.98	29.1	19.3	0	7.71	84.9	343	276	0	4.6	458	7.26
WINONA PWS	190	39.5	6.69	0	0.52	25	1.5	0.08	7.76	0	195	205	0	1.81	0	0
WOOD RIDGE ESTATES	171	40.6	0	0.14	2.38	20.6	1.7	0	7.87	18.3	187	186	0	61.3	64.8	1.58
WOODLAND HILLS SUBD	272	58.1	5.1	0	2.73	34.1	4.92	1.31	7.4	38.9	310	285	0	2.21	10.4	0
WOODRIDGE APARTMENTS	271	58.5	0	0.18	0	22.5	1.97	0.012	7.72	18.6	271	239	0	30.5	12.2	0
WOOLERY MHP	287	63.1	0	0.13	1.22	31.6	6.71	0	7.52	18.7	289	288	0	2.13	0	2.34
WRIGHT CITY PWS	314	62.2	50.7	1.39	9.54	31.1	64.7	0.13	7.32	80.8	473	283	0	8.14	0	1.42
WRIGHT COUNTY PWSD 1	247	53.7	0	0	1.25	30.9	2.16	0.14	7.82	0	238	261	0	1.22	0	0
WYATT PWS	285	73	6.29	0.31	2.52	21.2	8.12	0.013	7.79	6.76	292	270	0	2.6	0	0
YOUNGBERG ESTATES MHP	185	42.2	0	0	1.6	22.4	2.4	0	7.71	13.7	192	198	0	4.74	42.9	2.57
ZWANZIG MHP	313	62.6	0	0	0	37.3	2.75	0.011	7.63	12.5	310	310	0	4.26	8.98	0

MISSOURI DEPARTMENT OF NATURAL RESOURCES
Division of Environmental Quality
Water Protection Program
Public Drinking Water Branch
P.O. Box 176
Jefferson City, MO 65102
Phone 573-751-1077
Fax 573-751-3110
Web Address: dnr.mo.gov/env/wpp/dw-index.html

Former Hulett Lagoon Site
Combined PA/SI
Reference 29

SPECIFICATIONS

AND

CONTRACT DOCUMENTS

REMOVAL AND STOCKPILING OF

SLUDGE FROM THE HULETT LAGOON

CAMDENTON, MISSOURI

JERRY LYNN
E-10633
PROFESSIONAL

March, 1989

MISSOURI ENGINEERING CORPORATION
211 HWY. 63 SOUTH
ROLLA, MISSOURI

TABLE OF CONTENTS

Missouri Engineering Corporation
ENGINEERING CONSULTANTS
P O BOX 13
ROLLA, MISSOURI 65401 • PHONE 314-364-4003

April 18, 1989

REMOVAL AND STOCKPILING OF
SLUDGE FROM THE HULETT LAGOON
CAMDENTON, MISSOURI

ADDENDUM NO. 1

This project to be bid May 2, 1989, at 1:30 p.m.

Item No. 1. Bidders are hereby notified of a pre-bid conference at City Hall, Camdenton, Missouri, at 1:00 p.m., April 26, 1989.

MISSOURI ENGINEERING CORPORATION

Charles Ray

Received By:

Ronald d McCormick

5/22/89
Date

INFORMATION FOR BIDDERS

BIDS will be received by City of Camdenton, Missouri (herein called the "OWNER"), at City Hall, Camdenton, Missouri until 1:30 PM, May 2, , 19 89 , and then at said office publicly opened and read aloud.

Each BID must be submitted in a sealed envelope, addressed to City Clerk, City Hall, at Camdenton, MO 65020. Each sealed envelope containing a BID must be plainly marked on the outside as BID for Removal and Stockpiling of Sludge from the Hulett Lagoon and the envelope should bear on the outside the BIDDER's name, address and license number if applicable, and the name of the project for which the BID is submitted. If forwarded by mail, the sealed envelope containing the BID must be enclosed in another envelope addressed to the OWNER at City Hall, Camdenton, Missouri.

All BIDS must be made on the required BID form. All blank spaces for BID prices must be filled in, in ink or type written, and the BID form must be fully completed and executed when submitted. Only one copy of the BID form is required. Tied bids will not be considered by the OWNER.

The OWNER may waive any informalities or minor defects or reject any and all BIDS. Any BID may be withdrawn prior to the above scheduled time for the opening of BIDS or authorized postponement thereof. Any BID received after the time and date specified shall not be considered. No BIDDER may withdraw a BID within 90 days after the actual date of the opening thereof. Should there be reasons why the contract cannot be awarded within the specified period, the time may be extended by mutual agreement between the OWNER and the BIDDER.

BIDDERS must satisfy themselves of the accuracy of the estimated quantities in the BID schedule by examination of the site and a review of the drawings and specifications including ADDENDA. After BIDS have been submitted, the BIDDER shall not assert that there was a misunderstanding concerning the quantities of WORK or of the nature of the WORK to be done.

The OWNER shall provide to BIDDERS prior to BIDDING, all information which is pertinent to, and delineates and describes, the land owned and rights-of-way acquired or to be acquired.

ADVERTISEMENT FOR BIDS

CITY OF CAMDENTON, MISSOURI
(Owner)

Separate sealed bids for Camdenton Sludge for Removal and Stockpiling of Sludge from the Hulett Lagoon will be received by Brenda Colter, City Clerk at the office of City Hall, Camdenton, Missouri 65020 until 1:30 o'clock (XXM. - P.M., ___ S.T. X D.S.T.) May 2, 1989, and then at said office publicly opened and read aloud.

The Information for Bidders, Form of Bid, Form of Contract, Plans, Specifications, and Forms of Bid Bond, Performance and Payment Bond, and other contract documents may be examined at the following:

City Hall, Camdenton, Missouri 65020

Missouri Engineering Corporation

211 Hwy. 63 South, Rolla, MO 65401

Copies may be obtained at the office of Missouri Engineering Corporation located at 211 Hwy. 63 South, Rolla, MO 65401 upon payment of $ 10.00 for each set. Any plan holder, upon returning such set promptly and in good condition, will be refunded $ -0-.

The owner reserves the right to waive any informalities or to reject any or all bids.

Each bidder must deposit with his bid, security in the amount, form and subject to the conditions provided in the Information for Bidders.

Attention of bidders is particularly called to the requirements as to conditions of employment to be observed and and minimum wage rates to be paid under the contract, Section 3, Segregated Facility, Section 109 and E.O. 11246.

No bidder may withdraw his bid within 30 days after the actual date of the opening thereof.

______________________ ______________________
Date

The CONTRACT DOCUMENTS contain the provisions required for the construction of the PROJECT. Information obtained from an officer, agent, or employee of the OWNER or any other person shall not affect the risks or obligations assumed by the CONTRACTOR or relieve the contractor from fulfilling any of the conditions of the contract.

Each BID must be accompanied by a BID bond payable to the OWNER for five percent of the total amount of the BID. As soon as the BID prices have been compared, the OWNER will return the BONDS of all except the three lowest responsible BIDDERS. When the Agreement is executed the bonds of the two remaining unsuccessful BIDDERS will be returned. The BID BOND of the successful BIDDER will be retained until the payment BOND and performance BOND have been executed and approved, after which it will be returned. A certified check may be used in lieu of a BID BOND.

A performance BOND and a payment BOND each in the amount of 100 percent of the CONTRACT PRICE, with a corporate surety approved by the OWNER, will be required for the faithful performance of the contract.

Attorneys-in-fact who sign BID BONDS or payment BONDS and performance BONDS must file with each BOND a certified and effective dated copy of their power of attorney.

The party to whom the contract is awarded will be required to execute the Agreement and obtain the performance BOND and payment BOND within fifteen (15) calendar days from the date when NOTICE OF AWARD is delivered to the BIDDER. The NOTICE OF AWARD shall be accompanied by the necessary Agreement and BOND forms. In case of failure of the BIDDER to execute the Agreement, the OWNER may consider the BIDDER in default, in which case the BID BOND accompanying the proposal shall become the property of the OWNER. Upon default by the first low BIDDER the AWARD may then be made to the next lowest responsible BIDDER, or the WORK may be readvertised for a construction CONTRACT or otherwise, as the OWNER may decide.

The OWNER upon receipt of an acceptable performance BOND, payment BOND, Certificate of Insurance, and AGREEMENT signed by the party to whom the AGREEMENT was awarded, shall within a reasonable period of time sign the AGREEMENT and return to such party an executed duplicate of the AGREEMENT. The OWNER upon signing the AGREEMENT and within a reasonable period of time shall issue the NOTICE TO PROCEED.

The OWNER may make such investigations as deemed necessary to determine the ability of the BIDDER to perform the WORK, and the BIDDER shall furnish to the OWNER all such information and data for this purpose as the OWNER may request. The OWNER reserves the right to reject any BID

if the evidence submitted by, or investigation of, such BIDDER fails to satisfy the OWNER that such BIDDER is properly qualified to carry out the obligations of the Agreement and to complete the WORK contemplated therein.

A conditional or qualified BID will not be accepted.

Award will be made to the lowest responsive, responsible BIDDER, based on the total base bid for the work described in the proposal form.

All applicable laws, ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the PROJECT shall apply to the contract throughout.

Each BIDDER is responsible for inspecting the site and for reading and being thoroughly familiar with the CONTRACT DOCUMENTS. The failure or omission of any BIDDER to do any of the foregoing shall in no way relieve any BIDDER from any obligation in respect to its BID.

Further, the BIDDER agrees to abide by the requirements under Executive Order No. 11246, as amended, including specifically the provisions of the equal opportunity clause set forth in the SUPPLEMENTAL GENERAL CONDITIONS.

The low BIDDER shall supply the names and addresses of major material SUPPLIERS and SUBCONTRACTORS when required to do so by the OWNER.

The A/E is Missouri Engineering Corporation. The A/E's address is 211 South Highway 63 South, Rolla, Missouri 65401.

The Bidder agrees by the submission of his bid that he will not discriminate against any employee or applicant for employment because of race, creed, color, national origin, or sex in connection with the performance of work under this bid and/or contract.

PROPOSAL FORM

TO: City Council
Camdenton, Missouri

The UNDERSIGNED BIDDER, having examined the plans, specifications, general and special conditions and other proposed contract documents attached hereto and referred to herein, and any and all addenda thereto; the location, arrangement, and construction of existing railways, streets, roads, structures and facilities which affect or may be affected by the proposed work, the topography and condition of the site of the work, and having acquainted with and fully understanding (a) the extent and character of the work covered by this Proposal; (b) the location, arrangement and specified requirements of and for the proposed new structures and miscellaneous items or work appurtenant thereto; (c) the nature and extent of the excavations to be made and the type, character, and general condition of the materials to be excavated; (d) the necessary handling and rehandling of excavated materials; (e) all existing and local conditions relative to construction difficulties and hazards, labor, transportation, hauling, trucking, and rail delivery facilities; and (f) all other factors and conditions affecting or which may be affected by the specified work.

HEREBY PROPOSES to furnish all required materials, supplies, equipment, tools, and plant; to perform all necessary labor; and to construct, install, erect, and complete all work stipulated in, required by, and in accordance with, the proposed contract documents hereto attached and the plans and other documents referred to therein (as altered, amended, or modified by and all addenda thereto) at the prices stated below.

Bidder hereby agrees to commence work under this contract on or before date to be specified in written "Notice to Proceed" of the Owner and to fully complete the project within: 60 Consecutive Calendar Days

Removal and Stockpiling of Sludge from the Hulett Lagoon

Bidder further agrees to pay as liquidated damages the sum of $100.00 for each consecutive calendar-day thereafter as hereinafter provided in the General Conditions.

Bidder agrees to perfrom all the work as described in the specifications and as shown on the plans for the following prices.

REMOVAL AND STOCKPILING FROM THE HULETT LAGOON

Item No.	Description	Estimated Quantity	Unit Price	Extension
1.	Lagoon Dewatering by Pumping	50 Hrs.	$ 36.50	$ 1,825.00
2.	Lime added to Sludge, Complete	100 Tons	$ 14.60	$ 1,460.00
3.	Discing of Sludge	40 Hrs.	$ 43.25	$ 1,730.00
4.	Sludge Removal from Lagoon and Stockpiling, Complete	1500 Cu Yds	$ 7.73	$ 11,595.00
5.	Site Work at Stockpile Site	L.S.	$	2,920.00
		TOTAL	$	19,530.00

Listed above is the revised proposal form including unit prices and then extensions. This proposal form was revised due to excluding unit prices in the original bid; however the total remains the same. I agree to the above unit prices, extensions and total and agree to perform the work described above for these prices.

Ronald A. McCormick

Ronald A. McCormick, Owner
McCormick Gravel & Excavating

5/6/89
Date

It is mutually understood and agreed by and between the parties of this contract, in signing the agreement thereof, that time is of the essence in this contract. In the event that the Contractor shall fail in the performance of the work specified and required to be performed within the period of time stipulated therefor in the Contract Agreement binding said parties after due allowance for any extension of time which may be granted under provisions of the preceding paragraph, the Contractor shall pay unto the Owner, as stipulated liquidated damages and not as a penalty the sum stipulated therefor in the Proposal, for each and every calendar day that the Contractor shall be in default.

Liquidated damages will be waived for any period of time covered by a time extension granted by the Owner.

In the case of joint responsibility for any delay in the final completion of the work covered by this contract, where two or more separate contracts are in force at the same time and cover work on the same project and at the same site, the total amount of liquidated damages assessed against all contractors under such contracts, for any one day of delay in the final completion of the work, will not be greater than the approximate total of the damages sustained by the Owner by reason of such delay in completion of the work, and the amount assessed against any Contractor for such one day of delay will be based upon the individual responsibility of such Contractor for the aforesaid delay as determined by and in judgment of the Owner.

The Owner shall have the right to deduct said liquidated damages from any moneys in its hand, otherwise due, or to become due, to said Contractor, or to sue for and recover compensation for damages for non-performance of this contract at the time stipulated herein and provided for.

The undersigned hereby agrees to enter into contract on the attached contract forms and furnish the necessary bond and evidence that insurance of the kind and minimum limits specified is in force within ten days from the date of your acceptance of this proposal, to begin assembly of materials and equipment within ten days from receipt of executed copies of the contract and to complete said work within the indicated number of consecutive calendar days from and after the date of receipt from the Owner of a written work order.

If this proposal is accepted, and should (I) (We) for any reason fail to sign the contract within ten days, as above stipulated, the deposit which has been this day made with the Owner shall at the option of the Owner be retained by the Owner as liquidated damage for the delay and expense caused the owner but otherwise it shall be returned to the undersigned in accordance with the provisions set forth in Information for Bidders.

I have ____, have not ✓, participated in a previous contract, subject to the provisions of Section 301 of Executive Order 11246, as amended.

I have ____, have not ✓, submitted required compliance reports under such previous contracts.

DATED AT ______________________ this 2nd day

of May, 1989.

SIGNATURE:

If an individual: Ronald A McCormick doing business as

McCormick Gravel + Excavating

If a Partnership: ______________________

By ______________________ Member of the Firm

If a Corporation: ______________________

By ______________________

Title ______________________

ATTEST: ______________________
Secretary

(CORPORATE SEAL)

Business Address of Bidder RR 2 Box 193E
Versailles, Mo 65084

If Bidder is a corporation, supply the following information:

State in which incorporated ______________________

Name and Address of its:

President ______________________

____

Secretary ______________________

____

BIDDERS QUALIFICATIONS & SUBCONTRACTING

To evaluate the bidders' qualifications for acceptance on this project, the Owner requests the following:

a. Previous Experience (Projects of similar construction detail)

Location	Year	Type	Mat'l Type & Size	Approx. Bid
Lake of the Ozarks	1989	Dredging	5500 yd. mud + gravel 6" + under	$6500
Lake of the Ozarks	1989	Dredging	1500 yd mud + gravel 6" + under	$2500
Lake of the Ozarks	1989	Dredging	1500 yd mud + gravel 6" + under	$2500
Laurie, Mo	1989	construct pond	50 yd. X 100 yd. X 6 ft. dirt + rock	$5000

b. List of Equipment available for this job:

John Deere 690B Excavator

Caterpillar 955H Dozer/Loader

2 Dump Trucks (Tandem) John Deere tractor

500 gal water wagon with pump, 2' pump - Disc

c. List of subcontractors contemplated for this job:

(Name)	(Type of Work)
Carl Miller	Dump truck

This report is an integral part of the proposal.

Date 5/2, 19 89.

By Ronald Q McCormick

Title Owner.

CERTIFICATE OF OWNER'S ATTORNEY

I, the undersigned, ____, the duly
(Print)

authorized and acting legal representative of ______________________

____________________________, do hereby certify as follows:

I have examined the foregoing contract(s) of ______________________
(Contractor)

________________________________ and surety bonds and the manner of

execution thereof, and I am of the opinion that each of the aforesaid agreements have been duly executed by the proper parties thereto acting through their duly authorized representatives; that said representatives have full power and authority to execute said agreements on behalf of the respective parties named thereon; and that the foregoing agreements constitute valid and legally binding obligations upon the parties executing the same in accordance with terms, conditions and provisions thereof. In addition, I have examined the Certificate of Insurance for amounts and coverages per the requirements of the General Conditions/Supplemental General Conditions of the contract documents and find that adequate insurance is in full force and effect.

David T Welch
Project Attorney

6/5/89
Date

Address:

AGREEMENT

THIS AGREEMENT, made this 6TH day of June, 1989,

by and between City of Camdenton, Missouri, hereinafter called (name of Owner), (~~an individual~~)

and McCormick Gravel & Excavating doing business as (an individual), or (a ~~partnership~~), or (a ~~corporation~~) hereinafter called "CONTRACTOR".

WITNESSETH: That for and in consideration of the payments and agreements herein after mentioned:

1. The CONTRACTOR will commence and complete the construction of REMOVAL & STOCKPILING FROM THE HULETT LAGOON.

2. The CONTRACTOR will furnish all of the materials, supplies, tools, equipment, labor, and other services necessary for the construction and completion of the PROJECT described herein.

3. The CONTRACTOR will commence the work required by the CONTRACT DOCUMENTS within 3 calendar days after the date of the NOTICE TO PROCEED and will complete the same within 60 calendar days unless the period for completion is extended otherwise by the CONTRACT DOCUMENTS.

4. The CONTRACTOR agrees to perform all of the WORK described in the CONTRACT DOCUMENTS and comply with the terms therein for the sum of Nineteen thousand five hundred thirty and 00/100 Dollars $ 19,530.00.

5. The term "CONTRACT DOCUMENTS" Means and includes the following:

(A) Advertisement for BIDS

(B) Information for BIDDERS

(C) BID

(D) BID BOND

(E) Agreement

(F) General Conditions

(G) SUPPLEMENTAL GENERAL CONDITIONS

(H) Payment BOND

(I) Performance BOND

(J) NOTICE OF AWARD

(K) NOTICE TO PROCEED

(L) CHANGE ORDER

(M) DRAWINGS prepared by ______________________________

numbered __________ through __________, and dated ______________,

(N) SPECIFICATIONS prepared or issued by ______________________

Missouri Engineering Corporation ______________________,

dated March, 19 89.

(O) ADDENDA:

No. 1, dated April 18, 19 89

__________, ______________________, 19______

__________, ______________________, 19______

__________, ______________________, 19______

__________, ______________________, 19______

__________, ______________________, 19______

6. The OWNER will pay to the CONTRACTOR in the manner at such times as set forth in the General Conditions such amounts as required by the CONTRACT DOCUMENTS.

7. This Agreement shall be binding upon all parties hereto and their respective heirs, executors, administrators, successors, and assigns.

IN WITNESS WHEREOF, the parties hereto have executed or caused to be executed by their duly authorized officials, this Agreement in (4) copies each of which shall be deemed an original on the date first above written.

OWNER:

CITY OF CAMDENTON, MISSOURI

By Mac Webster

Name Mac Webster
(Please Type)

Title Mayor

(SEAL)

ATTEST:

Brenda Colter

Name Brenda Colter
(Please Type)

Title City Clerk

CONTRACTOR:

McCORMICK GRAVEL & EXCAVATING

By Ronald A. McCormick

Name Ronald A. McCormick
(Please Type)

Address R. R. 2, Box 193E

Versailles, MO 65084

Employer Identification Number:

42-1311948

(SEAL)

ATTEST:

✓ Danny L. Grupe

Name Danny L. Grupe
(Please Type)

expires 4-14-90

TECHNICAL SPECIFICATIONS

GENERAL

The Contractor shall provide the services, equipment and all appurtenances for the removal and stockpiling of the existing wastewater sludge located within the Hulett Lagoon. This lagoon has been eliminated as a part of the city's sewer system with construction of new sewer lines. The lagoon's primary contributor was a metal tubing company and hence, the metals content in the sludge accumulated in the lagoon is of a higher than normal concentration. Test results of samples taken of the sludge are given as an appendix to this report. The locations of the lagoon and the stockpiling area are also given in the appendices. The contractor's responsibility will be to stockpile the sludge at the site provided in accordance with the following specifications.

1. LAGOON DEWATERING: The Contractor shall pump the existing water from the lagoon and discharge it into the existing sewer manhole approximately 100 feet away, see Appendix I. The Contractor shall make all provisions as provided to prevent any solids to be discharged into the sewer system. The lagoon presently has 6" to 12" of water standing in the bottom with the sludge. The contractor shall dewater the sludge to at least a condition where the sludge will cake. The expected solids content is 12 to 15 percent. The contractor will be allowed to construct a sump pit in one of the lower parts of the lagoon. This pit must be of seal tight construction such as metal or fiberglass. This sump can be placed in an area where the sludge has been removed and down to an elevation of approximately 18" depth. The upper portion of the sump shall be provided with screens having   mesh wire to prevent

solids easy access to the sump. When the sump has been placed the outer edges shall be backfilled and sealed so as to prevent leakage around the sump box. This will be done by compacting the soil backfill into the excavated areas. The contractor shall be paid for this work at an hourly rate while the pump is in operation. The pump or pumps used shall not exceed a total of 200 GPM into the sewer system. The contractor has sole responsibility for insuring that the dewatering is directly pumped into the sewer line.

2. SLUDGE REMOVAL & STOCKPILING:

A. PREPARATION

The Contractor shall remove as much of the concentrated sludge from the cell as possible without excavating into the soils of the floor. This may be accomplished with a high lift or other piece of equipment as selected by the contractor. If the sludge is not suitable for removal using these methods, after dewatering and normal evaporation, the contractor may add lime and/or disc the sludge to assist in the drying. The proposal form provides for unit costs for these items but will not be paid for unless prior approval is obtained from the city.

After the contractor has removed as much of the sludge as possible from the cell bottom, then upon approval of the Engineers, a pit may be excavated to allow for collection of the remaining sludge. This will only be allowed in an area where tests can be performed to insure proper soils conditions will prevent seepage.

B. TRANSPORTATION

The Contractor shall load the sludge into a truck capable of a liquid tight performance. A rubber seal, gasket, or sealant material between the tailgate and the bed and a bed cover shall be required to pervent leakage of sludge materials from the truck while in transit to the stockpile location. All trucks shall be inspected prior to leaving the site to insure that seepage is not occuring. The contractor is totally responsible for cleaning up any seepage or spills that occur in any area between the two sites.

The Contractor shall provide a water tank or other means, at the stockpile site, to allow the trucks to be cleaned on the exterior of the bed, should accumulation cause for spillage on the return trips.

C. STOCKPILING

The stockpiling site is located approximately 150 linear feet from the county road. The Contractor shall provide his own access to the stockpile area at the location designated. The Contractor shall provide clearing, install culverts, crushed stone, etc. as necessary for his operations.

Before stockpiling begins, the contractor shall plow 2 furrows around the site, except for the area on the higher side, needed for truck access to the area. These furrows shall be sufficient to prevent drainage from the site. The area to be encompassed is approximately 160 feet in diameter.

The sludge shall be stockpiled to a height of no more than 2 feet.

The Contractor shall level the sludge after is is dumped from the trucks as necessary so as to normally maintain this height of less than 2 feet. This could be accomplished once daily.

This access road as provided by the contractor shall remain in place after the contractor's work has been completed.

BASIS OF PAYMENT OF SLUDGE REMOVAL

The sludge was checked for the thickness of the layer at varying points in the lagoon. Two piles of up to 18" thickness are located at each of the inlet pipes. The remainder of the cell is covered with sludge ranging basically in thickness from 6" to 12". The amount of sludge to be removed has been shown on the proposal form at 1500 cubic yards. Actual quantities are believed to be less. Final payment will be based on the actual amount of sludge removed and stockpiled having at least a 12% solids content. The size and number of trucks shall be recorded showing the total trips of each. This shall be used to determine the actual quantity removed. If discrepancies are encountered in the size and number of loads, then the stockpile area shall be guided as a cross check. This will all be done with a member of the construction crew present.

SECTION 1 CALCULATIONS

I. Determination of Acreage for Sludge Disposal

A. Limitations

1. Maximum cumulative copper limit of 500 bls./acre

2. Camdenton Airport

a. Field No. 1 25.0 acres

b. Field No. 2 17.4 acres

B. Conversion Factors

1. 1 MG/L = 1 ppm

2. Weight of water = 62.4 lbs/cu ft

3. Weight of lagoon sludge = 1.2 x weight of water

= (1.2) (62.4) = 74.88 lbs/cu ft

C. Information from Test Reports and References

1. Average metal analysis for ten copper samples = 24,464 MG/L

D. Calculation of Acreage Using DNR Guidelines

1. Total sludge limit of copper in dry tons/acre

a.

Metal	ppm			lbs./dry ton
Cu	24,464	x	0.002 =	48.928

b.

(1)	(2)	(3)
Cumulative Metal Limits	Sludge Metal	Total Sludge Limit dry tons/acre
lbs./acre	lbs/dry ton	col. 1 ÷ col. 2
500	48.928	10.219
250	48.928	5.1095

2. Weight of Dry Sludge

Quanity of Sludge = 1250 cu yd   % Solid of Sludge = 20%

$$\frac{(1250 \text{ cu yd})\ (27 \text{ cu ft/cu yd})\ (0.2)\ (74.88 \text{ lbs/cu ft})}{2000 \text{ lbs/ton}} = 253 \text{ Dry Tons}$$

3. Field No. 1 (25.0 acres) accepts a Cumulative Metal Limit of 500 lbs/acre. Apply 164 tons to Field No. 1. The 164 tons will be dispensed on 16.1 acres.

Field No. 2 (17.4 acres) accepts a Cumulative Metal Limit of 250 lbs/acre. Apply 89 tons to Field No. 2. The 89 tons will be dispensed on 17.4 acres.

II. Acidity Warrents Liming of the Disposal Site

A. Limitations

1. Disposal site should have a pH value of 6.0

B. Information from Test Reports

1. Field No. 1 & 2 at the Camdenton Airport has a Enm requirement of 4330 and 2195 respectively.

2. To determine the amount of limestone needed in tons/acre divide the ENM requirement by the guarantee of the limestone dealer.

C. Procedure for obtaining pH of 6.0

1. Apply lime to disposal site before applying the sludge

2. Disc lime into field before applying the sludge

3. Have soil samples taken to verify an acquired pH of 6.0.

III. Dewatering, Storage and Disposal of Sludge

A. Limitations

1. The sludge will be transported by a dump truck with the means to protect leakage or spillage of the sludge.

B. Information from Test Reports

1. On May 16, 1988 the sludge contained an average of 11.5% soild.

C. Procedure

1. Dewatering of sludge should occur by removal of liquids and Natural evaporation. Discing and Liming sludge maybe used to assist coagulation.

2. Transport sludge by dump truck to a designated storage area at the Camdenton Airport.

3. Precautions should be taken to contain the sludge while stockpiled. A berm will be necessary around the temporary storage site at the airport to contain any run-off.

4. A Dry Sludge Applicator should be used to apply th sludge onto Field No. 1 & 2.

Note:

1. The sludge must be thoroughly mixed before being land applied due to the variability of the metals concentration throughout the lagoon as shown by the sample report dated April 19, 1988.

2. Percent solids concentrations must be run daily on the sludge when it is being applied to ensure the loading rate can be calculated as the application progresses.

3. Upon completion of the work, a summary must be submitted to the Department of Natural Resources.

SECTION 2 REFERENCES

1. Agricultural Use of Municipal Wastewater Sludge - A Planning Guide
   Missouri Department of Natural Resources
   Division of Environmental Quality
   January 1985

2. Process Design Manual for Dewatering Municipal Wastewater Sludges
   U. S. Environmental Protection Agency
   Office of REsearch and Development Municipal Environmental Research Laboratory
   October 1982 EPA - 625/1-82-014

Metal Limitations

See Table 4 for maximum recommended heavy metal loadings. The metals listed in Table 4 are those which are most common in domestic sludges. For other industrial contributors See Table 4-A and contact the Department for any other parameters. Calculate which is the most limiting metal and the number of years to reach the limit at the proposed application rate. A sample worksheet is provided (Appendix B-1).

ppm metal x .002 = lbs. metal per dry ton

TABLE 4
Maximum Cumulative Amounts of Heavy Metals
Recommended for Privately Owned Farmland

Metal	kg/ha (pounds/acre in parenthesis) Soil Cation Exchange Capacity (meq/100 g soil)		
	CEC 0 - 5	CEC 5 - 15	CEC 15 +
Cadmium	5 (4.5)	10 (9)	20 (18)
Chromium	560 (500)	1120 (1000)	2250 (2000)
Copper	140 (125)	280 (250)	560 (500)
Lead	560 (500)	1120 (1000)	2250 (2000)
Nickel	140 (125)	280 (250)	560 (500)
Zinc	280 (250)	560 (500)	1120 (1000)

APPENDIX B-2 SLUDGE WORKSHEET - CONSERVATIVE MANAGEMENT

Facility ______________ Address ______________ Date ______________

STEP 1 - LAB DATA (see page 27)

A) SLUDGE ANALYSIS (Expressed on dry solids basis)

	ppm		lbs/dry ton
Total Kjeldahl Nitrogen	______	x .002 =	0
Cadmium (Cd)	0		0
Chromium (Cr)	17,053		26.106
Copper (Cu)	24 464		48.928
Nickel (Ni)	112.58		0.225
Zinc (Zn)	4,161		8.322
Other	64,720		129 440
Other Solids	______	ppm ÷ 10,000 =	____ %

B) SOIL TEST ANALYSIS (See Page 13)

pH ______ limestone needed ______ ENM

Cation Exchange Capacity (CEC) ______ me

STEP 2 - CROP AND SITE INFORMATION (See Page 23 & 24)

Previous Crop ______________

Future Crop ______________

Slope ____ % Buffer Areas ____ Feet from ____

Geologic Restrictions ______________

Pathogen Reduction ______________

Cattle Grazing ______________

Other ______________

Location ____ 1/4, Sec ____, Twp ____, Rge ____, County ____

STEP 3 - APPLICATION RATE

150 lbs/acre Total N ÷ ____ lbs Total N per dry ton of sludge (Step 1) = ____* dry tons/acre/year of sludge.

* For surface application the maximum rate is 2 dry tons.

STEP 4 - METALS EVALUATION

A) SLUDGE APPLICATION RATE ______ tons/acre/year from Step 2 or Step 3 or lower selected rate.

B) METALS ADDITIONS (See Page 17 & 18)

METAL	(1) CUMULATIVE METAL LIMITS LBS/ACRE (Table 4)	(2) LBS METAL PER DRY TON SLUDGE (Step 1)	(3) TOTAL SLUDGE LIMIT DRY TONS/ACRE (Col 1 ÷ Col 2)	(4)* METALS APPLIED PER YEAR LBS/ACRE (Col 2 x Step 4A)
Cd	18	0	–	
Cr	2000	26.106	76.611	
Cu	500	48.928	10.219	
Ni	500	0.225	2222.222	
Zn	1000	8.322	120.163	
Other				

* Column 4 should not be more than 10-15 % of Column 1.

Cu Most Limiting Metal (lowest in Column 3)

10.219 Dry Tons/Acre Total Sludge Limit (lowest Column 3)

C) SITE LIFE FOR METALS LOADING

______ Dry Tons/Acre Total Sludge Limit (Step 4B)

− ______ Dry Tons/Acre Sludge Applied Previously

= ______ Dry Tons/Acre Sludge Remaining to Reach Metal Limit

÷ ______ Dry Tons/Acre/Year Sludge Application (Step 4A)

= ______ No. Years To Reach Metals Limits

ENVIRODYNE ENGINEERS

12161 Lackland Road
St. Louis, Mo. [illegible]
[illegible]

REPORT OF ANALYSIS

CLIENT: Valda Mahoney
Missouri Engineering
Post Office Box 13
Rolla, MO 65401

REPORT DATE: April 19, 1988
SAMPLE ANALYZED: Ten sludge samples for metals analysis.

DATE RECEIVED: March 7,1988
P.O. #:

PROJ. #: 3222-00353

Parameter	# 1	# 2	# 3	# 4	# 5	# 6	# 7
Aluminum (MG/L)	55700	67400	97000	89300	79200	47100	52000
Chromium (MG/L)	12400	24300	28900	19000	24300	12300	15600
Cadmium (MG/L)	< 26.0	< 25.4	< 35.7	< 13.3	< 26.0	< 23.2	< 27.8
Copper (MG/L)	28800	24390	15100	52400	22600	34900	18700
Lead (MG/L)*	<101	< 99.1	<139	150	< 101	146	153
Nickel (MG/L)	91.0	119	179	215	110	85.9	89.0
Zinc (MG/L)	4910	4170	4330	5760	3810	4910	3710

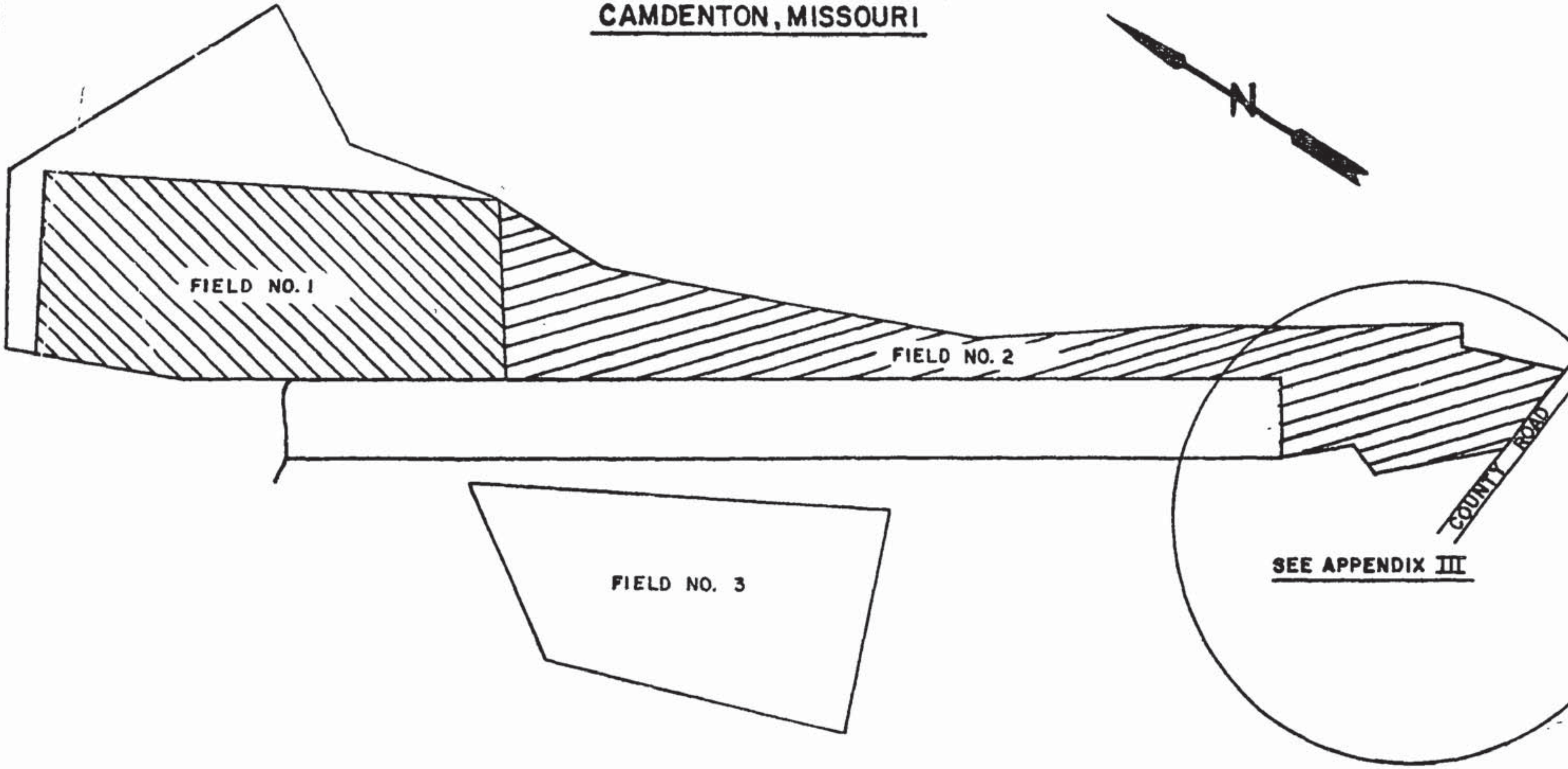
Parameter	# 8	# 9	# 10
Aluminum (MG/L)	53200	55100	51200
Chromium (MG/L)	11400	6430	15900
Cadmium (MG/L)	< 9.90	< 22.8	< 18.2
Copper (MG/L)	4340	10200	30100
Lead (MG/L)	113	155	125
Nickel (MG/L)	48.5	77.4	111
Zinc (MG/L)	2920	3470	3620

All results have been corrected for percent solids.
*All concentrations have been corrected for Aluminum interference.
See reverse side for "STANDARD CLAUSES".

/disk 25

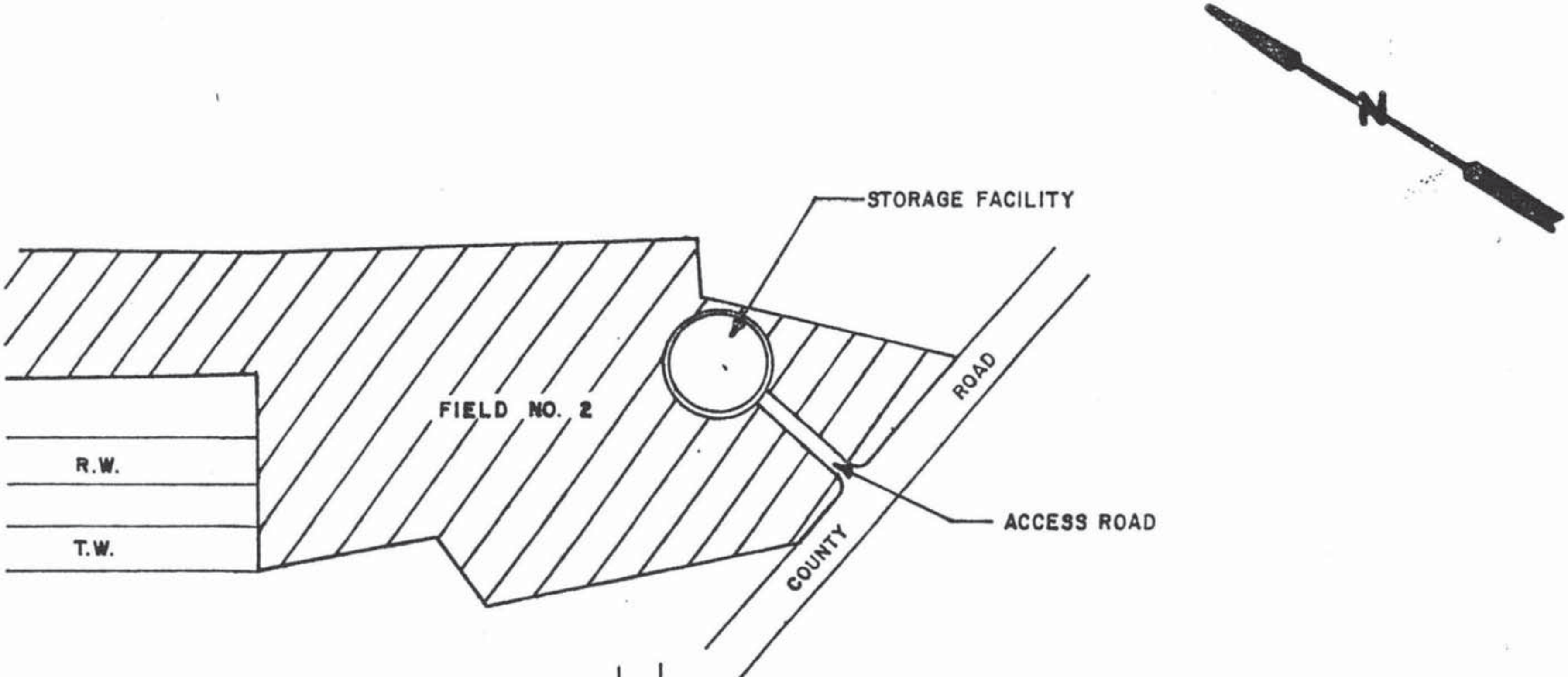
APPROVED: Lisa A. Lesley

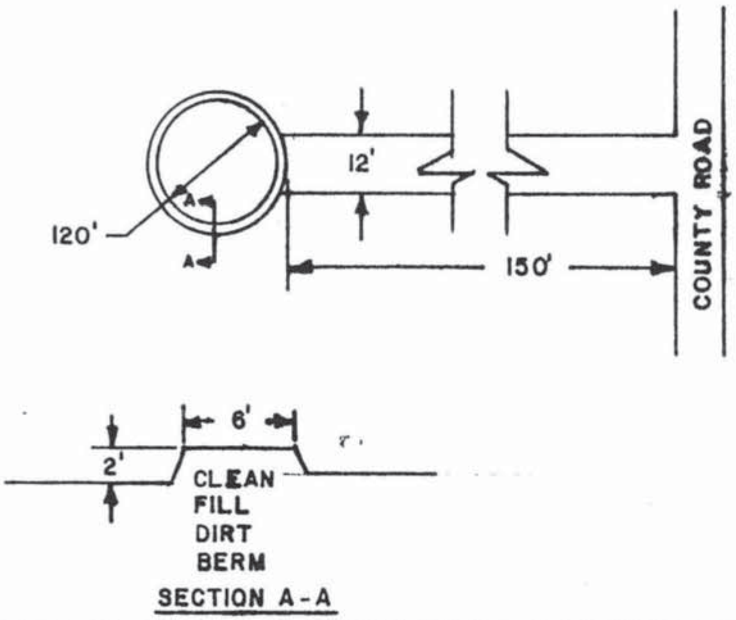
SLUDGE DISPOSAL SITES
CAMDENTON, MISSOURI



NOTE: FIELD NO. 2 AND PART OF FIELD NO I
TO BE USED FOR DISPOSAL.

MISSOURI ENGINEERING CORP CONSULTING ENGINEERS ROLLA, MISSOURI		
DRAWN BY	SCALE NONE	DRAWING NO
CK D BY	APP'D DATE	APPENDIX II

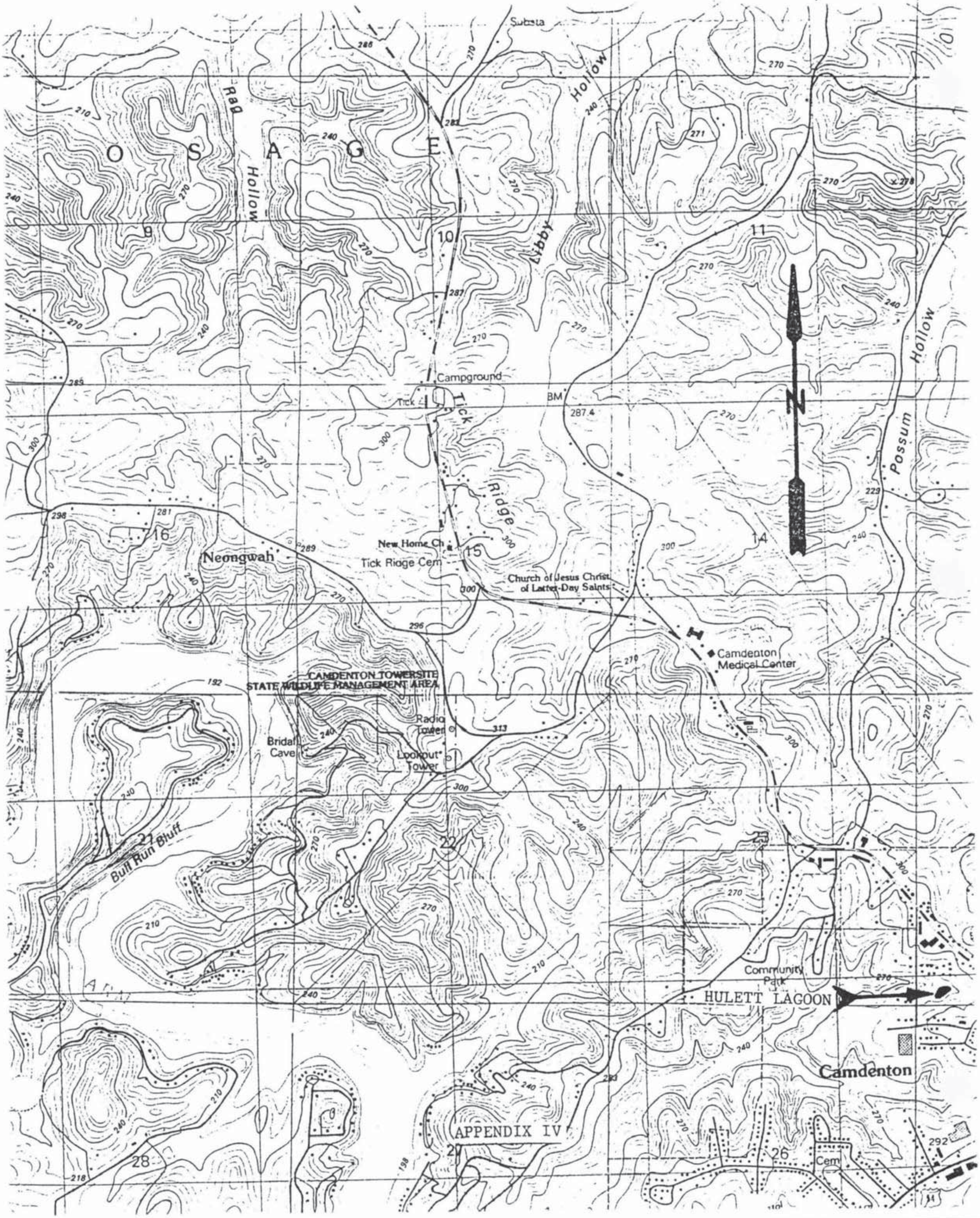




ACCESS ROAD & STORAGE FACILITY

APPENDIX III

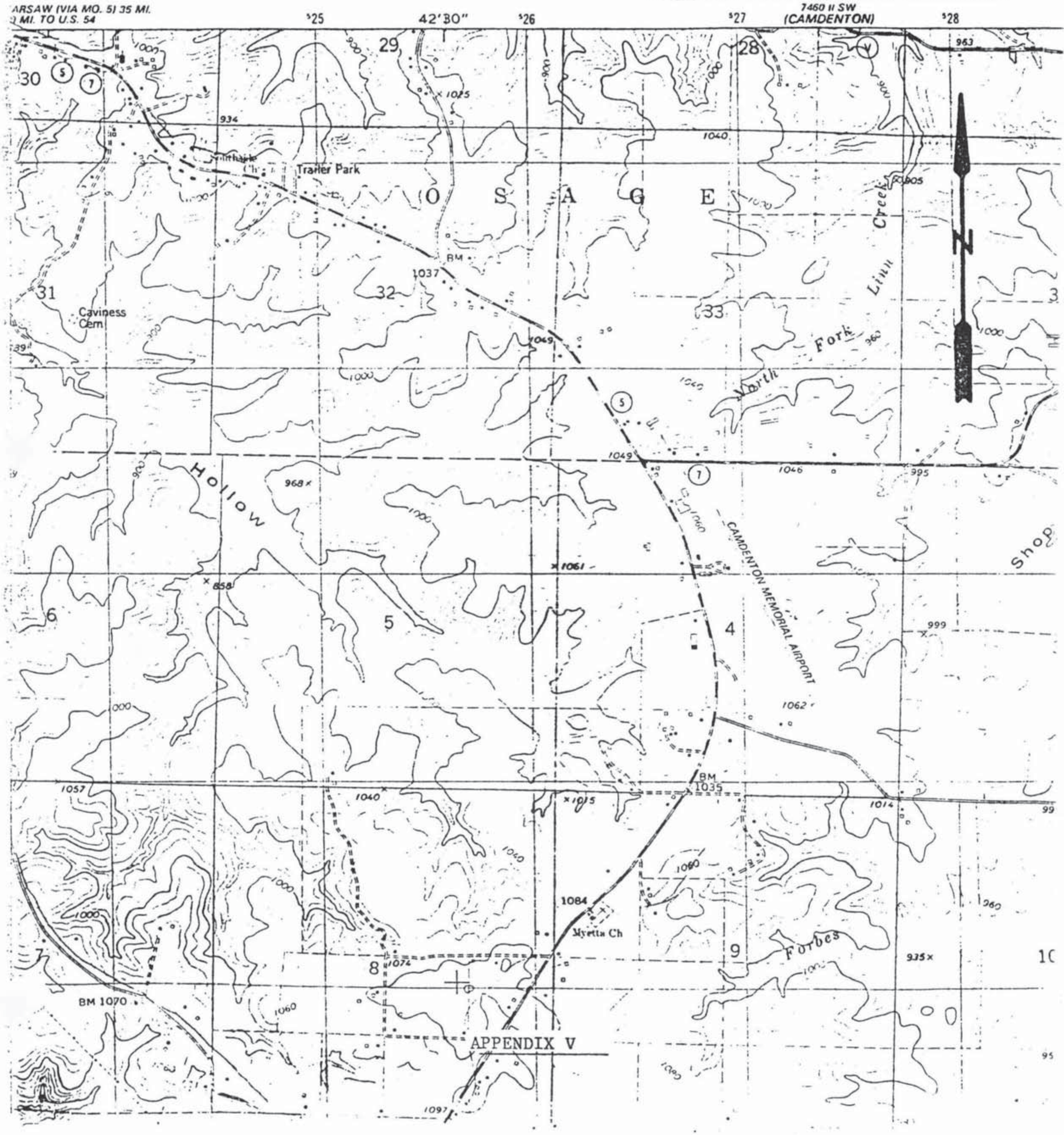
MISSOURI ENGINEERING CORP. CONSULTING ENGINEERS ROLLA, MISSOURI		
DRAWN BY	SCALE 1" = 200'	DRAWING NO.
CK'D. BY	APP'D. DATE	APPENDIX III



O S A G E
Rag Hollow
Libby Hollow
Possum Hollow
Campground
Tick
Tick Ridge
BM 287.4
New Home Ch
Tick Ridge Cem
Neongwah
Church of Jesus Christ of Latter-Day Saints
Camdenton Medical Center
CAMDENTON TOWERSITE STATE WILDLIFE MANAGEMENT AREA
Radio Tower
Bridal Cave
Lookout Tower
Bull Run Bluff
Community Park
HULETT LAGOON
Camdenton
Cem
APPENDIX IV

OR

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
WALLACE B. HOWE, STATE GEOLOGIST



APPENDIX V

ENVIRODYNE ENGINEERS

REPORT OF ANALYSIS

CLIENT: Valda Mahoney
Missouri Engineering
Post Office Box 13
Rolla, MO 65401

REPORT DATE: April 19, 1986
SAMPLE ANALYZED: Ten sludge samples for metals analysis.

DATE RECEIVED: March 7,1986

PROJ. #: 3222-00353
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Nickel (MG/L)	91.0	119	179	215	110	85.9	69.0
Zinc (MG/L)	4910	4170	4330	5760	3810	4910	3710

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Chromium (MG/L)	11400	6430	15900
Cadmium (MG/L)	< 9.90	< 22.8	< 18.2
Copper (MG/L)	4540	13200	30100
Lead (MG/L)	113	155	125
Nickel (MG/L)	48.5	77.4	111
Zinc (MG/L)	2920	3470	3620

All results have been corrected for percent solids.
*All concentrations have been corrected for Aluminum interference.
See reverse side for "STANDARD CLAUSES".

ppm 1 gram put in 100 mls of water = volume

APPENDIX VI
Page 1

/disk 25

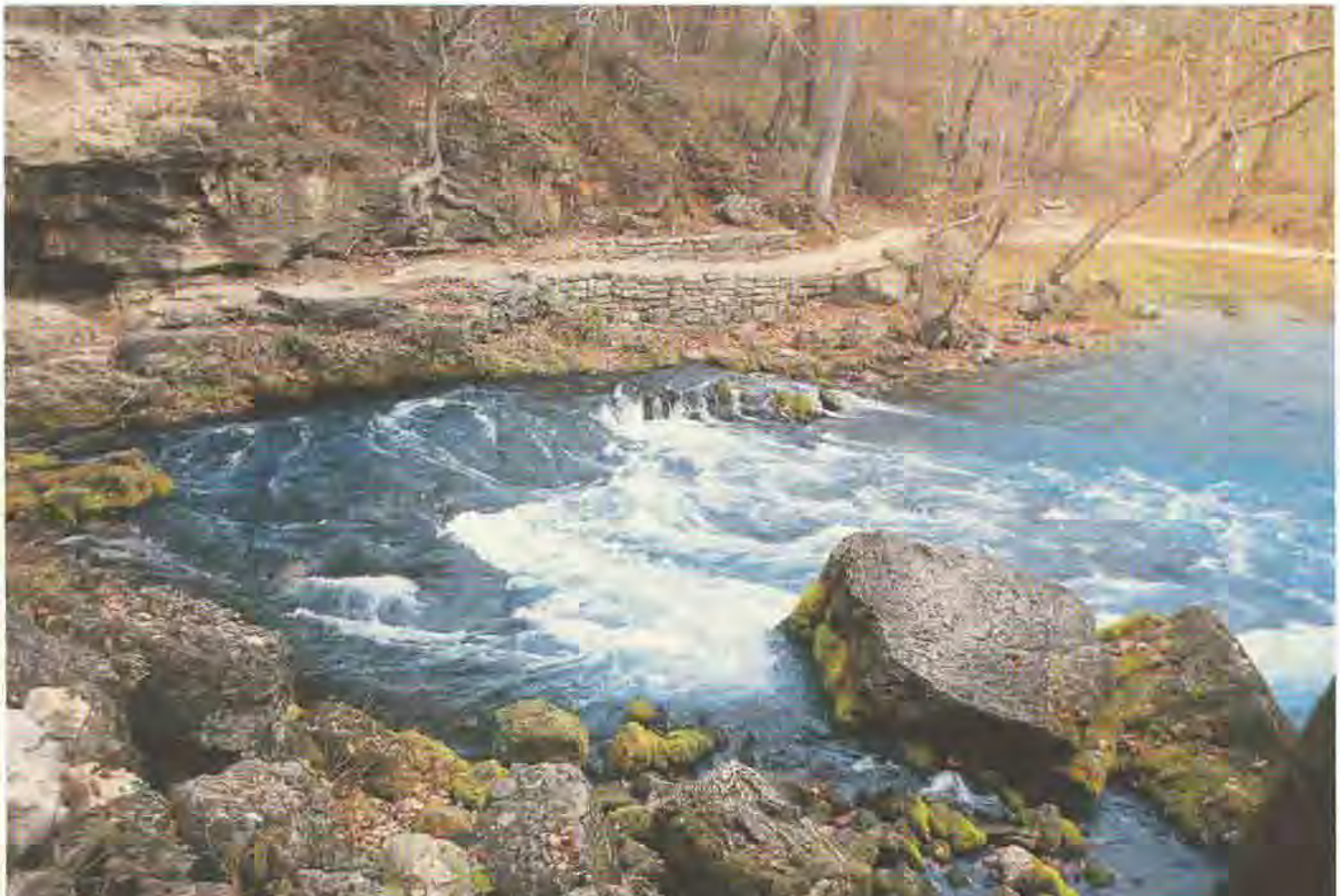
APPROVED: Lisa A. Lyeky

Water Resources Report Number 46

MISSOURI STATE WATER PLAN SERIES

VOLUME II

Groundwater Resources of Missouri



MISSOURI DEPARTMENT OF NATURAL RESOURCES

Division of Geology and Land Survey

COVER:
Big Spring, a few miles south of Van Buren in Carter County, is Missouri's largest spring. On an average day it feeds nearly 290 million gallons of high-quality groundwater into the Current River. Photo by Jim Vandike.

Water Resources Report Number 46

Missouri State Water Plan Series Volume II

Groundwater Resources of Missouri

by
Don E. Miller
and
James E. Vandike

1997

MISSOURI DEPARTMENT OF NATURAL RESOURCES
Division of Geology and Land Survey
P.O. Box 250, Rolla, Missouri 65402-0250
(573) 368-2100

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PREFACE

MISSOURI STATE WATER PLAN TECHNICAL VOLUME SERIES

The Missouri Department of Natural Resources State Water Plan Technical Volume Series is part of a comprehensive state water resource plan. This portion is designed to provide basic scientific and background information on the water resources of the state. The information in these technical volumes will provide a firm foundation for addressing present and future water resource needs and issues. Each volume in the series deals with a specific water resource component.

Volume I

The ***Surface Water Resources of Missouri*** contains a basin-by-basin assessment of Missouri's surface water resources. It discusses the effects of climate, geology and other factors on the hydrologic characteristics of major lakes, streams and rivers. It also assesses surface-water availability and development in the state.

Volume II

The ***Groundwater Resources of Missouri*** presents information on the availability and natural quality of groundwater throughout the state. It focuses on Missouri's seven groundwater provinces and includes their geology, hydrogeology, areal extent, general water quality, and potential for contamination. Aquifer storage estimates are given for each aquifer and county. The report also reviews the different types of water-supply wells in use and how water well construction techniques vary between areas and aquifers.

Volume III

Missouri Water Quality Assessment focuses on the current quality of Missouri surface water and groundwater. The volume looks at chemical, bacteriological and radiological water-quality, and natural and man-induced water-quality changes.

Volume IV

The ***Water Use of Missouri*** describes how Missouri is presently using its surface-water and groundwater resources. The report covers private and public water supplies, industrial and agricultural water uses, and water use for electrical power production, navigation, recreation, fish and wildlife.

Volume V

Hydrologic Extremes in Missouri: Flood and Drought provides basic information about flood and drought specific to Missouri. A historical perspective is given, as well as information that can be used in planning for hydrologic extremes. It also describes concepts and defines terminology helpful in understanding flood and drought.

Volume VI

Water Resource Sharing - The Realities of Interstate Rivers presents Missouri's views concerning interstate rivers. Because of its location, Missouri can be greatly affected by activities and water policy in the upper basin states of the Missouri and Mississippi river basins. Missouri policy can also affect downstream states on the Mississippi, Arkansas and White rivers. Many serious issues affecting these rivers have less to do with their physical characteristics than with political, economic and social trends.

Volume VII

Missouri Water Law provides an overview of the laws that affect the protection and use of Missouri's water resources. It supplies reference information about existing doctrines, statutes and case law.

EXECUTIVE SUMMARY

Missouri has an outstanding groundwater resource base and it is one of the state's most precious natural resources. There are more than a dozen major aquifers in Missouri with depths that vary from a few feet below land surface to more than 2,000 feet. Their areal extents range from a few hundred square miles for localized channel sandstone deposits, to that of the Ozark aquifer, which underlies more than 35,000 square miles of southern Missouri.

To assess Missouri's groundwater resources, the state has been divided into seven major groundwater provinces and two subprovinces. The boundaries are based on aquifer area, type of groundwater system, groundwater flow patterns, groundwater quality, and other factors.

Major groundwater provinces include the St. Francois Mountains, the Salem Plateau, the Springfield Plateau, Southeastern Lowlands, Northwestern Missouri, Northeastern Missouri, and West-Central Missouri. The Mississippi River alluvium and the Missouri River alluvium are treated as subprovinces.

Most Missouri groundwater originated as, and is replenshed by, precipitation. Shallow aquifers separated from the land surface by only a few feet of relatively permeable materials receive considerable recharge very quickly after precipitation occurs. Deeper aquifers that are overlain by low-permeability strata, or aquitards, are generally recharged much more slowly. Groundwater recharge rates vary widely, from less than an inch per year in parts of northern and west-central Missouri, to more than 12 inches in certain karst areas in southeastern Missouri.

Missouri's greatest groundwater resources lie south of the Missouri River. The Salem Plateau groundwater province contains the best groundwater resources. Thick dolomite and sandstone formations of Cambrian and Ordovician age underlie the area, and comprise the Ozark and St. Francois aquifers. The Missouri River alluvial aquifer lying south of the river is also included in this province. In the Salem Plateau groundwater province, these aquifers contain approximately 233 trillion gallons, or about 46.6 percent of the usable groundwater in the state. The St. Francois and Ozark aquifers extend to the west into the Springfield Plateau groundwater province, where they are overlain by several hundred feet of Mississippian-age limestones that comprise the Springfield Plateau aquifer. Groundwater storage in this province is estimated to be about 122.5 trillion gallons, or about 24.5 percent of the usable groundwater in Missouri.

Considering its size, the Southeastern Lowlands groundwater province contains the greatest volume of groundwater per unit area. Parts of the St. Francois and Ozark aquifers are usable in the northwestern part of this province. However, most of the usable groundwater is contained in thick deposits of shallow alluvium and deeper Tertiary- and Cretaceous-age sands. About 15.2 percent of the state's groundwater, an estimated 75.8 trillion gallons, is found in this southeastern corner of Missouri.

The remaining groundwater provinces south of the Missouri River contain more modest reserves of usable groundwater. In the St.

Francois Mountains groundwater province, the St. Francois aquifer is typically the only source of appreciable quantities of groundwater. Much of the area is directly underlain by Precambrian-age igneous rocks that are essentially impermeable, and that store or yield very little water. This area contains less than 0.2 percent of Missouri's groundwater, which is an estimated 919 billion gallons.

The West-Central Missouri groundwater province fares somewhat better. The freshwater-salinewater transition zone forms the boundary between the Springfield Plateau and West-Central Missouri groundwater provinces. Aquifers in Mississippian-, Ordovician-, and Cambrian-age rock south of this transition zone yield good-quality water, but the same aquifers north of the transition zone contain highly mineralized water. The northern part of this province borders the Missouri River and includes the Missouri River alluvium. Buried alluvial and glacial drift channels paralleling the river help to locally increase its groundwater resource base. Most of the area is underlain by low-permeability Pennsylvanian-age sedimentary strata that yield, at best, only meager volumes of marginal quality water. Groundwater storage estimates for this region are about 1.2 trillion gallons, or about 0.24 percent of the usable groundwater in Missouri. Cumulatively, the groundwater provinces south of the Missouri River contain about 86.7 percent of the states usable groundwater.

The remaining 13.3 percent of Missouri's potable groundwater occurs in the northern part of the state. In the Northwestern Missouri groundwater province, thick glacial materials and alluvial deposits along the Missouri River form the most significant aquifers. This area contains an estimated 10.9 trillion gallons of groundwater, or about 2.2 percent of the groundwater in Missouri. Deeper bedrock aquifers contain vast quantities of water, but the water is too highly mineralized to be considered potable.

Groundwater resources in the Northeastern Missouri groundwater province are much more varied. Glacial drift also underlies much of this area, but it is generally thinner and finer-grained than in northwest Missouri. Alluvial deposits bordering the Missouri and Mississippi rivers are important aquifers. Mississippian-age limestones yield modest amounts of marginal quality water in the northern part of the region, while south of the freshwater-salinewater transition zone, Mississippian, Ordovician, and Cambrian limestones, dolomites, and sandstones are important aquifers. This province contains about 11.2 percent of Missouri's potable groundwater, a volume of about 55.8 trillion gallons.

Statewide groundwater storage estimates show that aquifers in Missouri contain slightly more than 500 trillion gallons of usable-quality groundwater. This volume of water would cover the state to a depth of over 34 feet, or supply each of its 5.1 million residents 100 gallons of water per day for nearly 2,700 years. It is equivalent to the volume of rainfall that Missouri normally receives in nearly an 11-year period.

The volume of groundwater that Missouri has available is so staggering that it is difficult to imagine how such a resource could ever be depleted. In a few areas of the state it would be exceedingly difficult to use all of the available groundwater. However, groundwater resources are not evenly distributed across the state; neither is groundwater use. Production from a particular aquifer may be minimal throughout most of a county, but very high in an area of only a few square miles due to municipal, industrial or agricultural needs. It is quite possible to overuse an aquifer in one area, while the same aquifer a few miles away is essentially unused.

If groundwater resources were evenly distributed across the state, then each square mile of Missouri would contain about 7.17 billion gallons of water beneath it. Unfortunately, this is not the case. Average groundwater availability in Missouri north of the Missouri River is only about 3 billion gallons per square mile, while that of the southern part is much higher, about 9.4 billion gallons per square mile. Locally, groundwater storage in north-

ern Missouri can be much less than the average. Thus, a resource that many take for granted in the southern part of the state is considered a precious commodity in the north.

Ideally, the volume of water in Missouri aquifers should be kept relatively constant. If more water is removed from the aquifer than is replenished by recharge, groundwater levels begin to decline. As depth to groundwater increases, the costs of well construction, well deepening, and pumping all increase accordingly. The safe yield of an aquifer is the amount of water that can be withdrawn from it without producing an undesired result, such as the intrusion of poor-quality water and greatly increased pumping costs. Aquifer withdrawals that exceed the safe yield of the aquifer can cause problems ranging from local, minor drawdown or water-quality changes, to serious water-level decline problems including dewatering of existing wells. Alternative water sources should be explored and used where groundwater use exceeds the safe yield of an aquifer.

A sizeable percentage of Missouri's usable groundwater is in aquifers that are relatively expensive to exploit. For example, the St. Francois aquifer in the St. Francois Mountains area is fairly shallow. However, in southwestern Missouri it may be more than 2,000 ft below land surface. So, even though it is considered a groundwater resource, it is mostly unused because shallower, more productive aquifers are available throughout much of the Ozarks.

Another factor to consider is that the quality of water is very important in determining its potential use. Groundwater contamination due to improper waste disposal, inappropriate land use, accidental spills of potential contaminants, and other factors can cause a usable aquifer to essentially become unusable, at least for an extended period of time.

Although groundwater is a vast resource in Missouri, it is also a finite resource. Unlike many western states where groundwater recharge rates are so low that groundwater is not replenished, most Missouri aquifers receive considerable recharge in most years. With proper management and protection, Missouri's groundwater resources can continue to provide high-quality water to meet many of the states domestic, municipal, industrial, agricultural, and recreational needs. Avoiding aquifer over-use and protecting groundwater from contaminants are two ways to best ensure its continued availability for future generations.

INTRODUCTION

Hidden beneath the varied landscapes of Missouri is one of the state's most treasured and important natural resources. It's neither coal, petroleum, nor natural gas, which are three natural resources that are certainly important and have brought wealth to many people. Nor is it minerals, though they too are an important economic benefit to Missouri. This hidden treasure is water, and to be more specific, groundwater.

Missouri's water resource base is divided into surface water and groundwater. As the name implies, surface water is water that is found on the Earth's surface. It is the water flowing in rivers and streams and impounded in lakes and ponds. (For more information on Missouri's surface-water resources, see ***Surface Water Resources of Missouri***, *Missouri State Water Plan, Volume I*.) Groundwater is water that occurs beneath the Earth's surface. It is ultimately supplied and replenished by precipitation that finds its way into the subsurface where it moves through and is stored in bedrock and other earth materials. Geologic units that can store and release significant quantities of water are called *aquifers*. Many aquifers exist in Missouri.

People need many things in order to thrive, but basic survival requires oxygen, food, and water. Oxygen, of course, is the most immediate concern; without it a human will quickly perish. Food is a far less pressing matter. Although the stomach may protest loudly, healthy individuals have been known to live for several weeks without nourishment. One cannot survive that long without water. Depending upon temperature, exertion and other factors, humans need between two quarts and a gallon of drinking water each day. At most a person can survive only a few days without water.

Although man can survive on a gallon of water per day, society can't. In reality, the amount of water necessary for survival is but a tiny fraction of the amount of water needed to support a society such as ours. A modern household can be operated with as little as 40 gallons of water per day per capita (gpdc). More realistically, the average household uses closer to 100 gpdc for domestic needs. When commerce, industry, power generation and other components of society are added, per capita water needs jump to more than a thousand gallons of water per day per person.

Missouri occupies an area of about 69,709 square miles, and the geologic conditions across the state vary greatly. There are more than a dozen major aquifers underlying various parts of the state. In some areas, three or more aquifers are present. In other areas, where groundwater resources are poor, there may be just one aquifer or none at all.

To assess Missouri's groundwater resources, the state has been divided into seven major groundwater provinces. These provinces include the St. Francois Mountains, Salem Plateau, Springfield Plateau, Southeastern Lowlands, Northwestern Missouri, Northeastern Missouri, and West-Central Missouri. An eighth area—the Missouri and Mississippi river alluvial aquifers—was evaluated separately. However, county and groundwater province storage estimates include the Missouri-Mississippi alluvial aquifer water that is within each respective area.

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PHYSIOGRAPHY

Missouri is located in the midcontinent of the United States and is bounded by the states of Iowa on the north, Nebraska, Kansas and Oklahoma on the west, Arkansas on the south, Illinois on the east, and Tennessee and Kentucky on the southeast (figure 1). The state is divided into 114 counties; the city of St. Louis is not considered to be a part of any county and is not counted as a county.

Figure 1. Missouri and surrounding states.

The state is drained by three major river systems—the Missouri River, which forms the western boundary of the state from the Iowa line to Kansas City, the Mississippi River, which forms most of the eastern boundary of the state, and the Arkansas River, which drains the southwestern corner of the state.

The United States is divided into 34 regions called physiographic provinces, which are grouped into major divisions. These provinces are described primarily on the basis of their geologic structure, distinctive landforms, climate, vegetation, soils, water, and other

factors. The boundaries between the provinces are generally distinctive, and show the structural or geologic differences.

Missouri is located within three major physiographic divisions—the Atlantic Plain, the Interior Plains, and the Interior Highlands. All of these are large regions that contain parts of several states. The part of Missouri within the Atlantic Plain is the southeastern corner of the state, which is commonly called the Bootheel. Here, the Atlantic Plain division has been further subdivided with Missouri placed into the Southeastern Lowlands subprovince of the Coastal Plain physiographic province (figure 2).

Much of northern and western Missouri is within the Interior Plains division. The part of this division that lies in northern Missouri is within the Dissected Till Plains subprovince of the Central Lowlands physiographic province. The part of western Missouri within the Interior Plains is the Osage Plains subprovince of the Great Plains physiographic province.

The remainder of Missouri is in the Ozark Plateau physiographic province of the Interior Highlands major division. The Ozark Plateau is further subdivided into the Springfield Plateau, the Salem Plateau and the St. Francois Mountains.

The physiographic regions discussed in this report will be the smallest subdivisions—the Dissected Till Plains, Osage Plains, Springfield Plateau, Salem Plateau, St. Francois Mountains and Southeastern Lowlands.

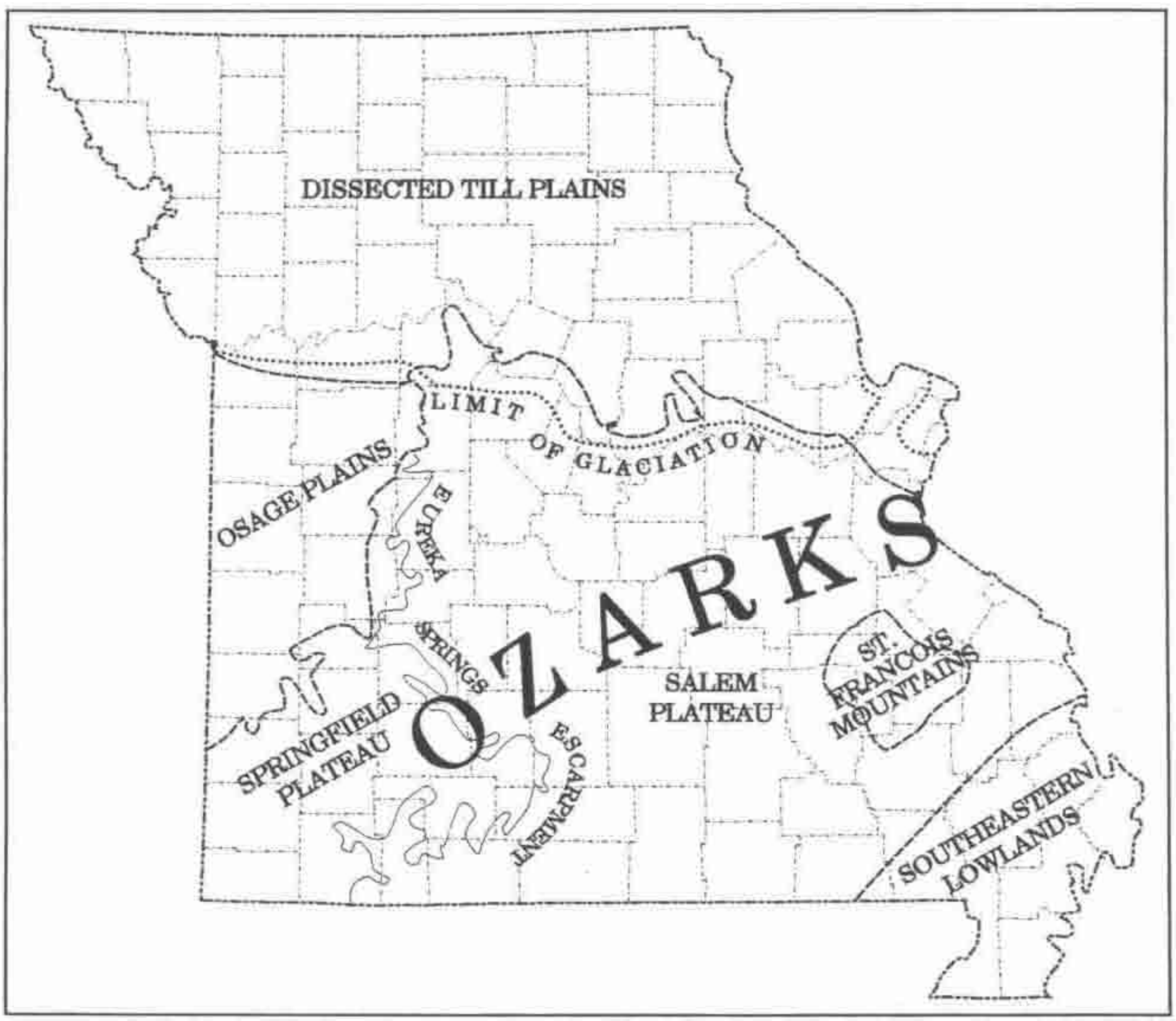


Figure 2. Map showing physiographic regions and features of Missouri.

GEOLOGIC OVERVIEW OF MISSOURI

The geology of Missouri is more complex and varied than is often expected for a state in the midcontinent region. Bedrock formations underlying the state range in age from Precambrian to Tertiary, and the unconsolidated deposits range in age from Cretaceous through Recent. There is a marked difference in rock type throughout the geologic section.

The oldest rocks exposed in Missouri are the Precambrian igneous rocks in the St. Francois Mountains in southeastern Missouri. The St. Francois Mountains form the core of the Ozark Uplift. Here, the eroded subdued remnants of Precambrian-age mountains are surrounded by younger marine sedimentary rocks. Cambrian- and younger Paleozoic sedimentary rocks were deposited on top of the Precambrian bedrock surface across the state. Deposition was not continuous throughout geologic time. The rock column is marked in several places by gaps in the record. These hiatuses of either nondeposition, or deposition followed by erosion, are mostly related to world-wide sea level changes or continental uplift or downwarping.

Mississippian-, Pennsylvanian-, and possibly Devonian-age sedimentary rocks were originally widespread across Missouri, but have been mostly removed by erosion throughout the Ozark region. Today, Mississippian rocks crop out mostly in the Springfield Plateau of southwestern Missouri, in central Missouri and in a small part of northeastern Missouri along the Lincoln Fold.

Rocks younger than Pennsylvanian-age occur in Missouri in only a few places, primarily in the Southeastern Lowlands. Here, several thousand feet of sands and clays were deposited during the Cretaceous and Tertiary periods. During the Pleistocene epoch, or Ice Age, continental ice sheets advanced and retreated across northern Missouri. The southern extent of glaciation roughly parallels the Missouri River in Missouri. Unconsolidated deposits left by the glaciers consist of clay, silt, sand, gravel and even boulders that were derived from the physical and chemical weathering of older rock units to the north. In most places, the glacial deposits are unsorted. In some places, however, sediments were deposited by water, particularly in drift-filled preglacial channels.

During more recent times, over-bank flooding of present day rivers has left deposits of alluvium on river floodplains. The alluvium of the larger rivers, such as the Missouri and Mississippi, generally consists of clay, silt and fine sand in the shallower zones, and increasingly coarser sand and gravel in the deeper zones. The same alluvial deposits are found throughout most of the Southeastern Lowlands where the paths of the Mississippi, Ohio and St. Francis rivers have meandered.

Table 1 is a generalized geologic section of Missouri showing the age, rock type, special features, and general water-bearing characteristics of the geologic formations in Missouri. Figure 3 is a generalized geologic map of Missouri showing the distribution of the rocks discussed in the geologic section. The geologic map shows a roughly concentric distribution of rock formations centered around the St. Francois Mountains in the southeastern part of the state. The St. Francois Mountains

are eroded remnants of much older igneous mountains that exist today as knobs or hills. These hills or knobs were emergent islands when younger sedimentary rocks were being deposited in inland seas. The concentric pattern developed as subsequent, gentle and intermittent uplift occurred along the Ozark dome.

The Ozark dome or Uplift is a broad, asymmetrical arch (McCracken, 1971) whose eastern and southeastern sides dip or tilt more steeply, while the northern and western sides have a rather gentle dip. The axis of the uplift trends from the St. Francois Mountains to the southwestern part of the state. As erosion occurred, vast quantities of rock material were eroded away, and a radial drainage pattern developed. The Precambrian igneous and metamorphic rocks at the core of the uplift were exposed, leaving sediment-filled basins between them, and all other, younger rocks dipping or tilted away from them. As a result, rocks that are at the surface around the St. Francois Mountains are found several thousand feet below the surface in northern and western Missouri.

Much of the subsurface geologic information available today is from studying samples of rock cuttings from water wells, mineral test holes, and oil and gas wells. Water well drillers typically save a small quantity of cuttings from each 5-foot interval of the well. The samples are processed by the Department of Natural Resources' (DNR) Division of Geology and Land Survey (DGLS) technicians, and studied microscopically by geologists who prepare a geologic log of each well that is studied. Routinely, companies drilling wells to test for minerals or oil use a core drill to collect rock cores in the zones of interest. The cores are cylindrical samples of rock that can be studied in much greater detail than the cuttings. To a trained observer, however, both rock core and cuttings are valuable data sources. As a service to Missouri citizens, the Division of Geology and Land Survey maintains a large collection of rock cores at the McCracken Core Library, and rock cuttings at the Land Survey building. Currently, the collection contains cuttings from more than 30,000 wells and about 1.8 million feet of rock core.

Missouri geologists recognized in the early 1900s that the identification of individual Cambrian and Ordovician formations from drill cuttings was extremely difficult. All of the samples had lithological similarities which made the identification of individual formations almost impossible. However, it was noted that the insoluble (non-carbonate) part of the sample could be used to identify particular zones and formations. From this, a technique of well logging called the *insoluble residue method* was developed. This system recognizes that each geologic horizon has unique assemblages of materials, usually silicious, which characterize it. Sample preparation involves dissolving the carbonate fraction of the sample with hydrochloric acid. The insoluble remainder, which includes chert, silica sand, metallic minerals, and other secondary materials, is examined microscopically. Over a period of many years, using insoluble residues, geologists developed a system to identify geologic formations using sequences of certain residue types. Using this method, it is possible not only to determine from which geologic formation the samples came, but also what region of the state.

Figure 4 shows a symplified version of an insoluble residue log that was prepared from drill cuttings collected from city of Rolla municipal well #14. The notations on the left side of the original strip log (not shown on figure 4) show the residue types identified by the geologist who logged the well. Each line on the sample log marks a five-foot interval. The color (or in the case shown here the pattern) inside the rectangles depicts the relative amounts of each mineral in the sample. In this way, a person studying the log can determine the percentage of constituents for that five-foot interval. The formation boundaries and names are indicated at the extreme left margin. The well log files at the Division of Geology and Land Survey contain more than 25,000 insoluble residue logs from mineral test wells, oil and gas wells, and water supply wells.

System	Series	Group	Geologic Unit	Hydrologic Unit
Quaternary	Holocene		Alluvium	Missouri and Mississippi rivers and in Mississippi embayment, 500-2,000 gpm. Yields are less along smaller rivers.
	Pleistocene		Loess, till, and other drift, sand and gravel	Drift and till typically yield 0-5 gpm. Drift-filled preglacial valleys typically yield 50-500 gpm.
Tertiary	(undifferentiated)			Wilcox Group (Mississippi embayment only), 50-400 gpm.
Cretaceous	(undifferentiated)			McNairy Formation (Mississippi embayment only), 200-500 gpm
Pennsylvanian	(undifferentiated)			Northern and west-central Missouri, 1-20 gpm, regionally forms a confining layer.
Mississippian	Chesterian		(undifferentiated)	Springfield Plateau aquifer in Southwest Missouri. Mississippian aquifer in central and east Missouri. Post-Maquoketa aquifer in the St. Louis area. 5-30 gpm.
	Meramecian		(undifferentiated)	
	Osagean		Keokuk Limestone Burlington Limestone Elsey Formation Reeds Spring Formation Pierson Limestone	
	Kinderhookian	Chouteau	Northview Formation Sedalia Formation Compton Limestone	Ozark confining unit
			Hannibal Formation	
Devonian	(undifferentiated)			
Silurian	(undifferentiated)			
Ordovician	Cincinnatian	Maquoketa	Orchard Creek Shale Thebes Sandstone Maquoketa Shale Cape Limestone	
	Mohawkian	Decorah	Kimmswick Limestone (three formations) Plattin Limestone Joachim Dolomite Dutchtown Formation St. Peter Sandstone Everton Formation	Ozark aquifer (upper) Yield is greatest from St. Peter Sandstone. Yields of 5 to 50 gpm are possible.
	Whiterockian			
	Canadian		Smithville Formation Powell Dolomite Cotter Dolomite Jefferson City Dolomite Roubidoux Formation Gasconade Dolomite Gunter Sandstone Member	Ozark aquifer (lower) Yields vary greatly with location and well depth. In Salem Plateau, yields are typically 50-500 gpm. In Springfield Plateau and central Missouri, yields are typically 500 to 1,200 gpm.
Cambrian	Croixian		Eminence Dolomite Potosi Dolomite	
		Elvins	Derby-Doerun Dolomite Davis Formation	St. Francois confining unit.
			Bonneterre Formation Lamotte Sandstone	St. Francios aquifer. Yields of 10 to 100 gpm are possible.
Precambrian	(undifferentiated)		Igneous, metasediments, and other metamorphic rock.	Not a significant aquifer

[The stratigraphic nomenclature used in this report is that of the Missouri Department of Natural Resources, Division of Geology and Land Survey modified after Koenig (1961.)]

Table 1. Generalized section of geologic and stratigraphic units (from Vandike, 1993).

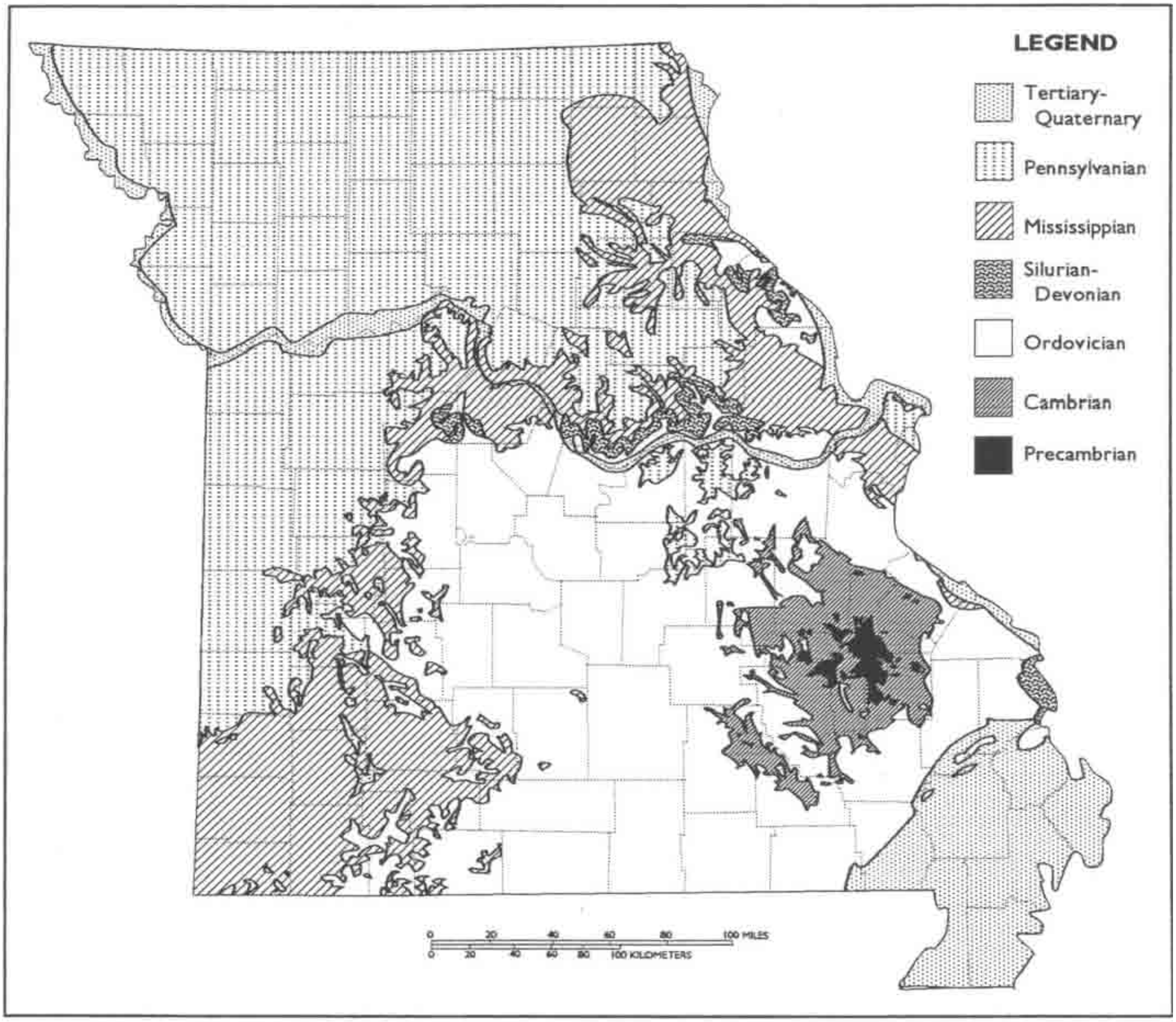


Figure 3. Generalized geologic map of Missouri.

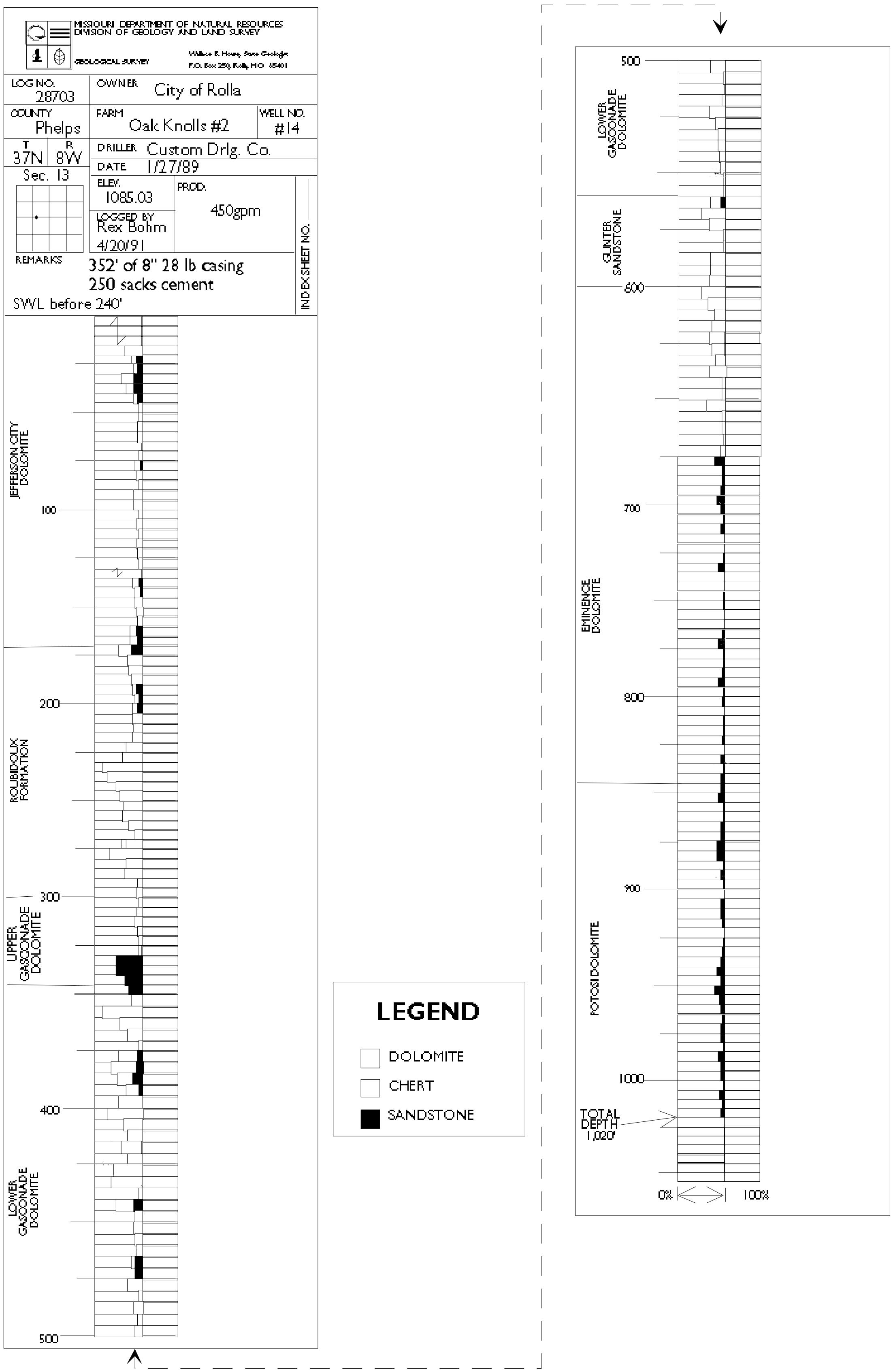


Figure 4. Insoluble residue log of Rolla city well #14.

GENERAL HYDROGEOLOGY

Groundwater is contained in and moves through aquifers. Various definitions exist for the term aquifer, but generally an aquifer is defined as a saturated, permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients. Nearly all of the geologic formations in Missouri are capable of storing and discharging varying amounts of groundwater. However, not all of the units yield water in sufficient quantities to be considered important aquifers. The distinction between an important aquifer and one which is not is often subjective, and to a great extent depends on location and perspective. A rural resident living in northwestern Missouri might be pleased to have a well that yields one to three gallons per minute (gpm). Since groundwater resources are generally poor in this area, and yields greater than this are uncommon, such a yield would be considered good by local standards. Another person living in central Missouri, where well yields are generally better, would likely be disappointed if his well yielded less than 15 gpm. For an irrigation system, public water supply, or an industry requiring substantial water, any quantity less than several hundred gallons per minute may not be considered significant.

AQUIFER PARAMETERS

Aquifers can be classified into two general types, *unconfined aquifers* and *confined aquifers*. In an unconfined or water table aquifer, the *water table* forms the upper boundary of the aquifer. The water table is the two-dimensional surface between the unsaturated materials above the water table and the saturated materials below. The water level in a well drilled into an unconfined aquifer is the water table. A confined or artesian aquifer is bounded above and below by confining beds that have much lower permeabilities than the aquifer. The water level in a tightly cased well drilled into a confined aquifer will usually be some distance above the top of the aquifer due to the head pressure on the water in the aquifer. If the water level in the well rises above land surface, it is termed a flowing artesian well. The height to which water will rise in the well is represented by the potentiometric surface of the aquifer at that location.

Not all geologic materials are capable of transmitting significant quantities of water. Some geologic formations or materials are *aquicludes*, which are geologic units that are not capable of transmitting significant quantities of water under ordinary gradients. Geologic units or materials that are not permeable enough to be considered aquifers, but are permeable enough to be considered important in terms of regional groundwater flow are called *aquitards*. For example, the Northview Formation in southwest Missouri is considered an aquitard. The Northview contains considerable shale and siltstone, which greatly limits the movement of water through it. However, on a regional scale, the downward movement of water through the Northview

provides considerable recharge to the underlying aquifer. Most geologic units in Missouri are either considered aquifers or aquitards. Only a few geologic units have the hydrologic characteristics of an aquiclude.

There are several other hydrologic terms that are important in describing the movement of groundwater and the hydrogeologic characteristics of aquifers. The *permeability* or *hydraulic conductivity* of an aquifer is defined as the rate of flow of water through a unit cross-section of aquifer under a hydraulic gradient of one. In general, the higher the permeability, the greater the potential volume of groundwater that can move through the unit. A related term, *transmissivity*, is equal to the permeability times the saturated thickness of the aquifer. The term transmissivity is used to describe the water-yielding characteristics of the entire vertical extent of an aquifer, whereas permeability is generally used to describe the water-yielding characteristics of only a particular zone.

The storage characteristics of an aquifer, commonly called the *coefficient of storage*, or simply the *storativity*, is defined as the volume of water the aquifer takes into or releases from storage, per unit surface area, per unit change in water level or head. The units are dimensionless. The storativity of a barrel is one. Each unit volume of the barrel will take into or release an equivalent volume of water. Much of the volume of an aquifer, however, is rock, sand and gravel, or other geologic materials. Only a small fraction of the total volume of rock is available for water storage. In unconfined aquifers, the water is released from storage by the dewatering of openings in the aquifer. The storativity of an unconfined aquifer is generally called its *specific yield*, and it is related to the effective porosity of the rock. The *effective porosity* is the ratio of hydraulically connected void space in the rock to the total volume of rock. If all of the stored water within a given volume of an unconfined aquifer could be released, then the specific yield would be essentially equal to the effective porosity. However, some of the water in the pores remains behind because of surface tension, so the specific yield is always less than the effective porosity.

The specific yield or storativity of unconfined aquifers is typically between 0.01 and 0.3 (Freeze and Cherry, 1979). The storativity of confined aquifers is much smaller, generally from 5×10^{-3} to 5×10^{-5}. The low values of storativity for artesian or confined aquifers are due to the fact that water released from storage in these aquifers is derived by the compaction of the aquifer and its associated beds and by expansion of the water itself, while the openings in the aquifer remain saturated.

Aquifers are often named after the geologic formation that comprises them. Examples of this include the St. Peter Sandstone, the Missouri River alluvium, and the McNairy Formation. However, unless the specific geologic formation is hydrologically isolated from the units above and below it, it is generally best not to name the aquifer after the geologic unit. In Missouri, several geologic formations commonly comprise a single aquifer. For example, the Ozark aquifer is composed of the geologic units between the base of the Maquoketa Shale (in eastern Missouri) or Chattanooga Shale (in western Missouri) and the base of the Potosi Dolomite. Depending on location, the geologic formations included in the aquifer include the Kimmswick Limestone, Plattin Limestone, Joachim Dolomite, St. Peter Sandstone, Everton Formation, Smithville Formation, "Powell" Dolomite, Cotter Dolomite, Jefferson City Dolomite, Roubidoux Formation, Gasconade Dolomite, Eminence Dolomite, and the Potosi Dolomite. All of these formations are hydrologically connected; there are no major aquitards within the vertical sequence. However, not all of the zones are uniformly permeable. There are specific zones within several of the formations that typically yield most of the water, but all of the units are considered part of the aquifer.

POTABLE GROUNDWATER STORAGE IN MISSOURI

All of the potable groundwater in storage in Missouri originated as, and is recharged by, relatively local precipitation. During years of abundant precipitation, the volume of groundwater in storage generally increases and groundwater levels in shallow aquifers rise. During times of prolonged drought, water levels decline, and the total amount of water in storage decreases.

It is difficult to precisely measure the total volume of groundwater in storage in Missouri. As part of this report, groundwater storage volumes were estimated for the major aquifers in the state that yield potable quality water. Existing geologic and hydrogeologic information was used to calculate groundwater storage by county, aquifer, and groundwater province. The calculations reflect the amount of usable or drainable water that is estimated to be available in the aquifer.

It is estimated that during normal weather cycles, there is approximately 420.7 trillion gallons of potable water stored in the bedrock aquifers of Missouri, and another 25.8 trillion gallons of water stored in the alluvial sand and gravel deposits in the Missouri and Mississippi river floodplains and in the Southeastern Lowlands. Another 44.2 trillion gallons of water is estimated to be stored in the unconsolidated Cretaceous- and Tertiary-age sands and gravels underlying the alluvial deposits in the Bootheel. Glacial drift and other aquifers contain about 9.3 trillion gallons. The sum of the above yield a grand total of about 500 trillion gallons, or almost 1.53 billion acre-feet of fresh groundwater in storage in Missouri aquifers. Table 2 shows storage estimates of potable groundwater for each major aquifer and each county in Missouri.

GENERALIZED MISSOURI GROUNDWATER QUALITY

Water termed "fresh" or "potable" refers to water containing less than 1,000 milligrams per liter (mg/L) of total dissolved solids, and less than 250 mg/L each of sulfate and chloride. These criteria are based, in part, on secondary water-quality standards used by the Department of Natural Resources for public water supplies. Aquifers that contain potable water in the Ozarks generally contain highly mineralized water in other places. Thus, the total volume of groundwater in storage statewide is somewhat greater than the volume of freshwater available to Missourians.

In many areas of Missouri, the deep aquifer zones contain water that is of poor quality. Total dissolved solids, a parameter which is most often used to denote water quality, can greatly exceed the 500 mg/L public drinking water standard. Figure 5 is a map of Missouri showing a natural feature known as the freshwater-salinewater transition zone. Groundwater contained in deeper aquifer zones south of the transition zone generally contains less than 1,000 mg/L total dissolved solids, and less than 250 mg/L of chloride and sulfate, and is generally potable without treatment. North of the transition zone, groundwater in the same aquifer zones becomes increasingly mineralized and contains excessive total dissolved solids and chloride, and may contain excessive sulfate.

Another factor that appears to be related to the existence of the freshwater-salinewater transition zone, is the presence of hydrogen sulfide gas and higher dissolved radionuclides in groundwater paralleling the transition zone on the freshwater side. Near the transition zone in many areas across Missouri, gross alpha emissions exceed 15 picoCuries per liter, and radium 226 and radium 228 activities exceed 5 picoCuries per liter, the maximum levels allowed for public drinking water. Although it is possible to treat the water to remove the radionuclides, the added expense of removing them from the water and disposing of the slightly radioactive sludge produced by treatment, often causes the owners of small water systems to look for other sources of water.

It is beyond the scope of this report to address water quality in great detail. The reader is referred to ***Missouri Water Quality Assessment,*** *Missouri State Water Plan Volume III* (Brookshire, 1997) for a more detailed presentation of groundwater quality.

Table 2. Estimated quantity of potable groundwater in storage in Missouri aquifers (all values are in billion gallons).

County	St. Francois aquifer	Ozark aquifer [south of Missouri River]	Cambrian Ordovician aquifer [north of Missouri River]	Springfield Plateau aquifer [southwest Missouri]	Mississip--pian-age bedrock aquifer	Pennsyl-vanian-age bedrock aquifer	McNairy aquifer [Southwestern Lowlands]	Wilcox aquifer [Southeastern Lowlands]	Glacial Drift aquifer [north of Missouri River]	Missouri & Mississippi River alluvial aquifers [including Southeast Lowlands]	Other aquifers [including Moberly & Warrensburg sandstones]	County Totals
Adair									58.6			58.6
Andrew									239	29.3		268.3
Atchison									700	310		1010
Audrain			6257		830							7087
Barry	323	5642		306								6271
Barton	220	7982		671		1.3						8874.3
Bates	4.7	133		15.6		87.1						204.4
Benton	350	6842										7192
Bollinger	651	1841								226		2718
Boone			7261		232					54.2		7547.2
Buchanan									104	166		270
Butler	839	3296					1114			1924		7173
Caldwell									22.5			22.5
Callaway			9658		253					98.8		10009.8
Camden	668	5347										6015
Cape Girardeau	837	3128								349		4314
Carroll									199	410		609
Carter	521	1062										1583
Cass						73.2						73.2
Cedar	246	7736	238									8220
Chariton									384	174		558
Christian	437	11449		168								12054
Clark					75.6				58	88.1		221.7
Clay									57.8	91.5		149.3
Clinton									110			110
Cole	409	3986								47.7		4442.7
Cooper	245	5277		56.2						37.7	10.5	5626.4
Crawford	766	5431										6197
Dade	225	8064		435								8724
Dallas	453	6229										6682
Daviess									399			399
DeKalb									345			345

County	St. Francois aquifer	Ozark aquifer [south of Missouri River]	Cambrian Ordovician aquifer [north of Missouri River]	Springfield Plateau aquifer [southwest Missouri]	Mississip-pian-age bedrock aquifer	Pennsyl-vanian-age bedrock aquifer	McNairy aquifer [Southwestern Lowlands]	Wilcox aquifer [Southeastern Lowlands]	Glacial Drift aquifer [north of Missouri River]	Missouri & Mississippi River alluvial aquifers [including Southeastern Lowlands]	Other aquifers [including Moberly & Warrensburg sandstones]	County Totals
Dent	472	5905										6377
Douglas	849	11035										11884
Dunklin	218	436					2282	7552		3027		13515
Franklin	1145	9134								90.3		10369.3
Gasconade	652	5161								18		5831
Gentry									636			636
Greene	494	13256		483								14233
Grundy									453			453
Harrison									951			951
Henry	139	3050		87.1		39.6					8.8	3324.5
Hickory	244	4286		21.5								4551.5
Holt									150	455		605
Howard			119		12.3					99.9		231.2
Howell	773	8217										8990
Iron	190	344										534
Jackson						56.3				93.3	28.2	177.8
Jasper	201	7353		752								8306
Jefferson	854	3735			18.8							4607.8
Johnson	166	3088		85.8		47.7					60.4	3447.9
Knox					110				48.3			158.3
Laclede	801	7967										8768
Lafayette				1.3		63.9				80.4	82.4	228
Lawrence	256	7363		720								8339
Lewis					124				29.1	44		197.1
Lincoln			4250		96.5					124		4470.5
Linn									376			376
Livingston									456			456
McDonald	111	3526		243								3880
Macon									25.2			25.2
Madison	171	62.6										233.6
Maries	551	4955										5506
Marion					75.9					158		233.9

County	St. Francois aquifer	Ozark aquifer [south of Missouri River]	Cambrian Ordovician aquifer [north of Missouri River]	Springfield Plateau aquifer [southwest Missouri]	Mississip-pian-age bedrock aquifer	Pennsyl-vanian-age bedrock aquifer	McNairy aquifer [Southwestern Lowlands]	Wilcox aquifer [Southeastern Lowlands]	Glacial Drift aquifer [north of Missouri River]	Missouri & Mississippi River alluvial aquifers [including Southeastern Lowlands]	Other aquifers [including Moberly & Warrensburg sandstones]	County Totals
Mercer									601			601
Miller	557	4947										5504
Mississippi							2138	3762		2257		8157
Moniteau	348	4783								18.8		5149.8
Monroe					80.8				13		3.6	97.4
Montgomery			8447		263					51.1		8761.1
Morgan	368	6194										6562
New Madrid							1877	8088		4248		14213
Newton	131	3760		654								4545
Nodaway									1089			1089
Oregon	908	2973										3881
Osage	634	5687								56.8		6377.8
Ozark	534	12196										12730
Pemiscot							2696	11785		3709		18190
Perry	470	1343			60.1					175		2048.1
Pettis	350	7963		101								8414
Phelps	492	6326										6818
Pike			2230		156					77.4		2463.4
Platte									18.7	155		173.7
Polk	398	9439		117								9954
Pulaski	574	2581										3155
Putnam									659			659
Ralls					37							37
Randolph									1.3		5.5	6.8
Ray									32.3	277		309.3
Reynolds	488	1439										1927
Ripley	642	2720								105		3467
St. Charles			5866		511					686		7063
St. Clair	362	7571		189		22.3						8144.3
St. Francois	471	36.5										507.5
Ste. Genevieve	678	469			46.7					12.5		1206.2
St. Louis	189	940			188					142		1459

County	St. Francois aquifer	Ozark aquifer [south of Missouri River]	Cambrian Ordovician aquifer [north of Missouri River]	Springfield Plateau aquifer [southwest Missouri]	Mississip-pian-age bedrock aquifer	Pennsyl-vanian-age bedrock aquifer	McNairy aquifer [Southwestern Lowlands]	Wilcox aquifer [Southeastern Lowlands]	Glacial Drift aquifer [north of Missouri River]	Missouri & Mississippi River alluvial aquifers [including Southeastern Lowlands]	Other aquifers [including Moberly & Warrensburg sandstones]	County Totals
Saline				5.2		18.2				180	171	374.4
Schuyler									55.4			55.4
Scotland					29.5				74.1			103.6
Scott	559	1865					682	104		2042		5252
Shannon	1037	5193										6230
Shelby					85.7				29.5			115.2
Stoddard	1220	2982					1389	684		3266		9541
Stone	248	8697		54.7								8999.7
Sullivan									468			468
Taney	380	9510										9890
Texas	1107	6768										7875
Vernon	96	4786		320		44						5246
Warren			6710		47.2					109		6866.2
Washington	665	2033										2698
Wayne	594	2857								49.1		3500.1
Webster	620	11614		19.9								12253.9
Worth									348			348
Wright	771	8890										9601
Aquifer Totals	31312.7	328881.1	50798	5744.3	3333.1	453.6	12178	31975	9190.8	25812.9	370.4	500049.9

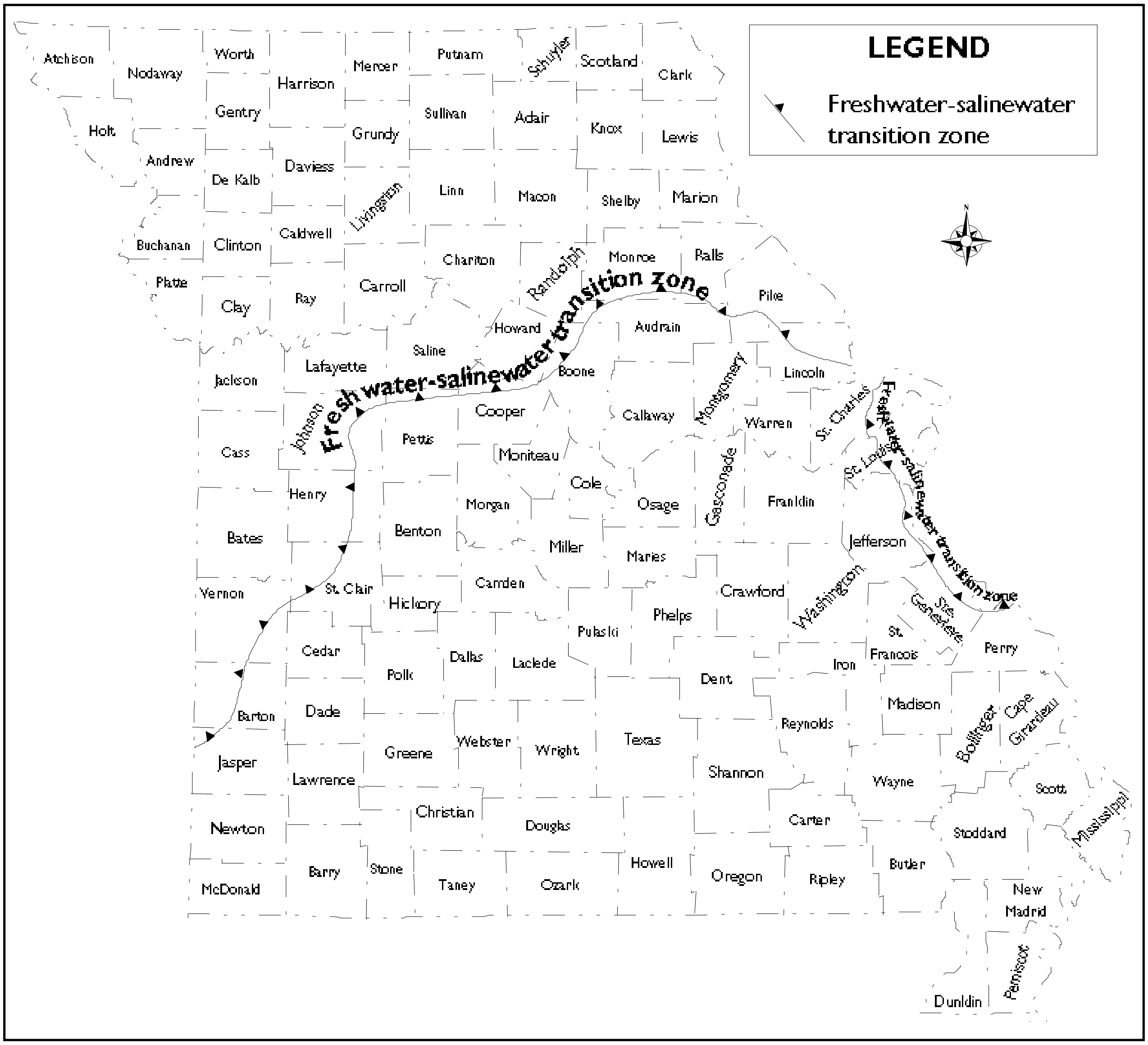


Figure 5. Freshwater-salinewater transition zone.

THE HYDROLOGIC CYCLE

All of Missouri's water resources, surface water and groundwater, originate as precipitation, most in the form of rainfall. Considerable surface water enters Missouri from neighboring states, but most of Missouri's groundwater travels much shorter distances. Rainfall amounts vary significantly from northwest to southeast across the state (figure 6). During an average year, extreme northwestern Missouri receives less than 35 inches of precipitation while the southeastern corner of the state receives about 48 inches.

PRECIPITATION, EVAPOTRANSPIRATION, AND RUNOFF

Although yearly precipitation in Missouri typically ranges from 35 inches to 48 inches, only a fraction of this becomes either surface-water runoff or groundwater recharge (figure 7). Most of the precipitation is lost back into the atmosphere through evaporation, or is used by plants through transpiration (figure 8). Combined, these losses are called *evapotranspiration*, and on the average they range from about 26 inches in northwestern Missouri to about 30 inches in southeastern Missouri. Generally, evapotranspiration rates are highest during hot summer months and least during winter and spring. However, before evapotranspiration can occur the soil must contain moisture. During droughts, evapotranspiration may actually be low because of lack of soil moisture.

Like precipitation and evapotranspiration, runoff in Missouri increases from about 5 inches per year in northwestern Missouri to about 20 inches per year in southeastern Missouri. These values are based on discharge measurements at long-term gaging stations on Missouri rivers and streams. The discharge measurements, though, include groundwater inflow into the streams as well as direct surface-water runoff into them. In northern and western Missouri where streams flow through low-permeability glacial drift and Pennsylvanian-age bedrock, little groundwater enters the streams. However, in the Ozark region where rivers and streams cut through thick limestone and dolomite formations there are many springs that feed the rivers and streams. Much of the surface water in Ozark rivers and streams is provided by groundwater that flows into the streams through springs, seeps, and general groundwater inflow.

TYPES OF GROUNDWATER RECHARGE

Diffuse Groundwater Recharge

Groundwater recharge can be broadly categorized into two types—*diffuse recharge* and *discrete recharge*. Diffuse recharge is the relatively slow infiltration of water from the Earth's surface into the groundwater system. Diffuse recharge is generally slow, and consists largely of water moving downward through soil materials and weathered rock, through permeable sand and gravel in unconsolidated sediments or small cracks and crevices in bedrock. Diffuse recharge can occur almost anywhere that the soils or surficial

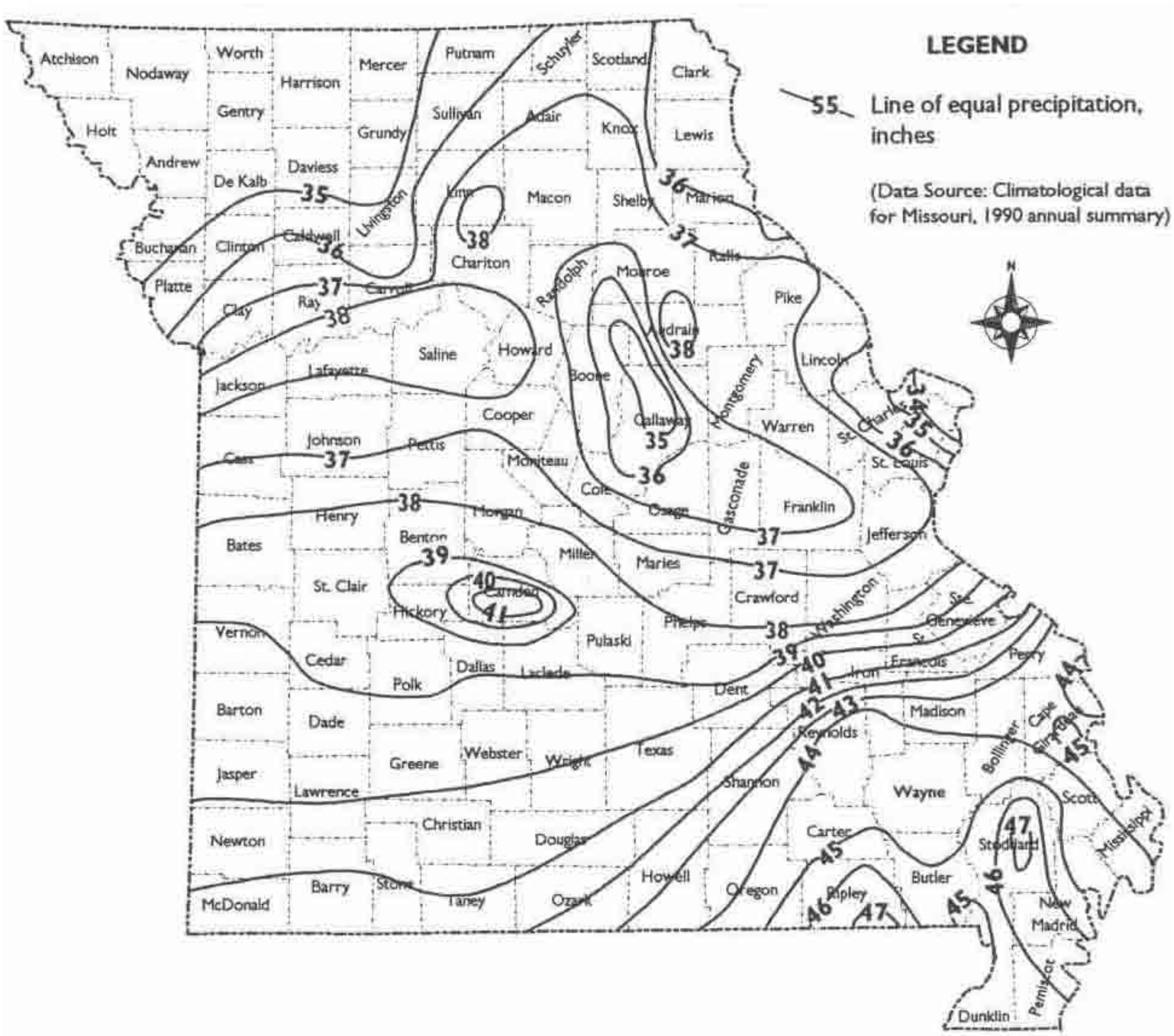


Figure 6. Long-term average annual precipitation in Missouri.

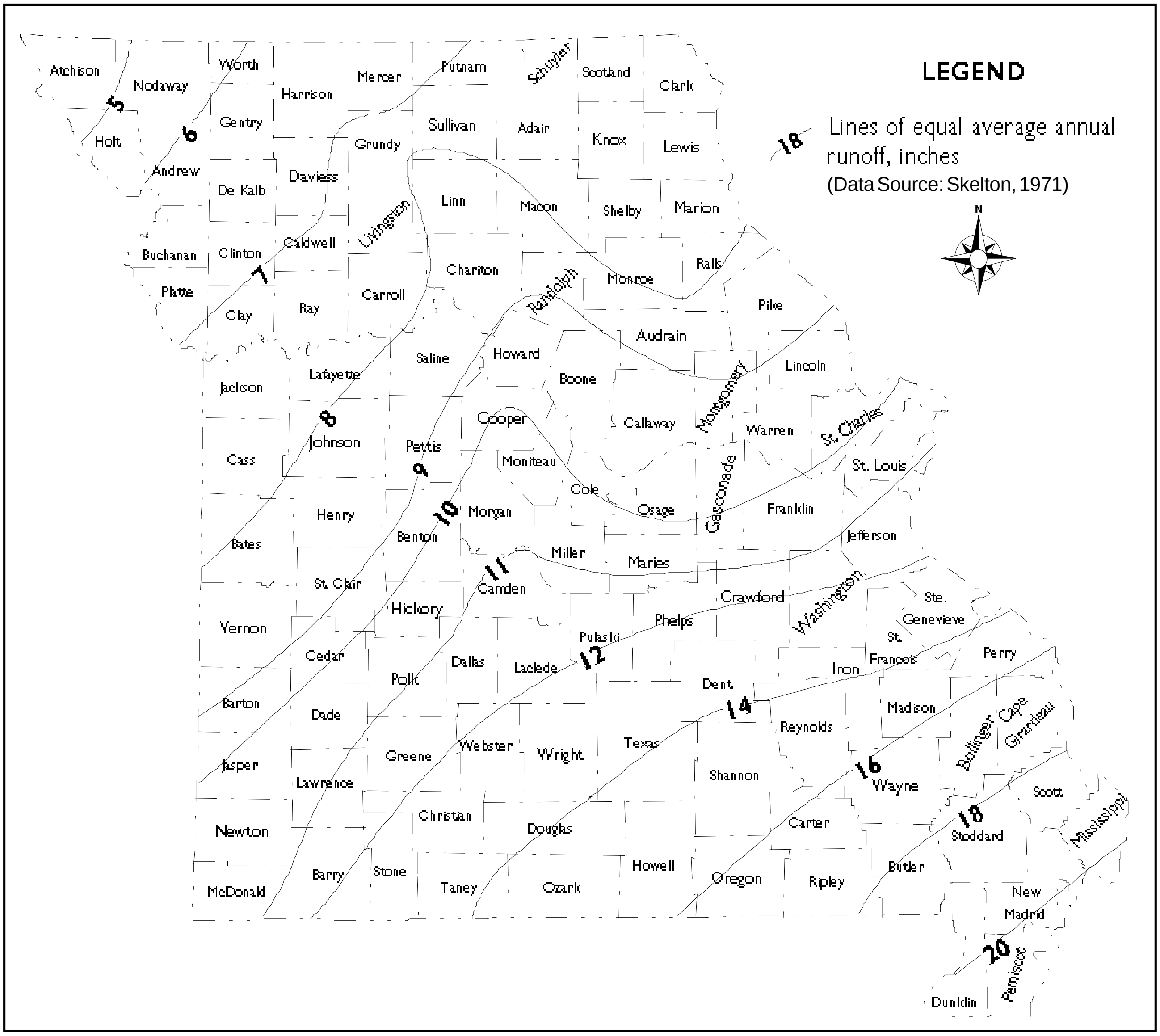


Figure 7. Average annual runoff in Missouri.

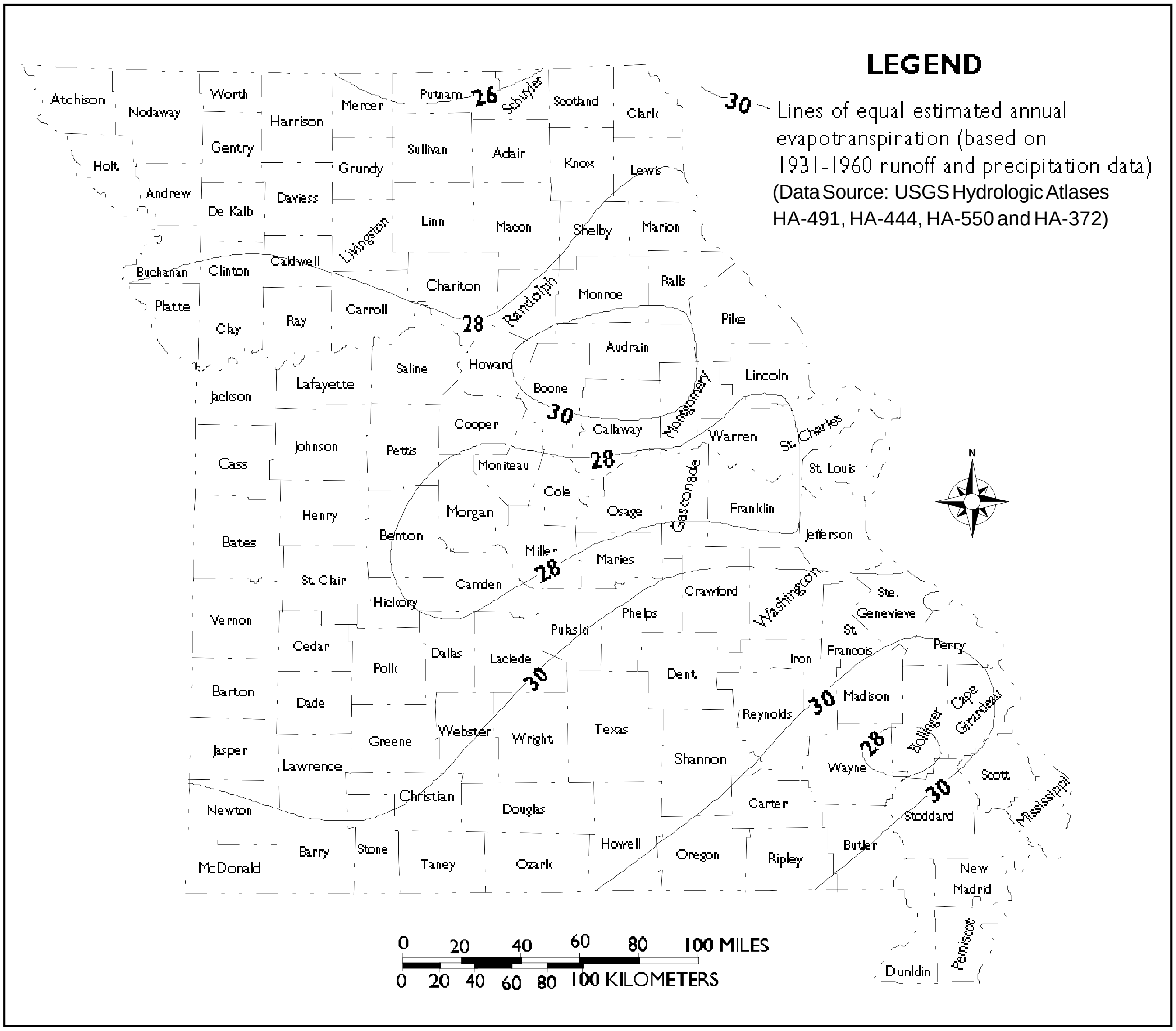


Figure 8. Estimated annual evapotranspiration losses in Missouri.

materials are permeable enough to allow water movement. This type of recharge occurs in the glacial drift areas of northern Missouri as well as the alluvial plain of the Bootheel and nearly all points in between. The more permeable the surficial materials and shallow bedrock are, the greater the recharge.

In terms of diffuse groundwater recharge, the amount of precipitation an area receives may not be as important as the temporal and spacial distribution of precipitation. For example, an intense rainstorm occurring for a brief time during the summer generally provides less groundwater recharge than a gentle, prolonged rain lasting an extended period in the spring or fall of the year; even though the rainfall amounts are the same in both events. Direct runoff after a brief, hard rain during the summer months is much greater and more rapid than runoff after a prolonged, gentle rain during the spring or fall. The slope of the terrain, the type of soil, and the amount of vegetation are also important factors to consider when determining the efficiency of a region to have significant diffuse recharge to underlying aquifers.

Diffuse recharge typically provides a relatively small volume of recharge per unit area, but since it occurs over broad regions it ultimately supplies very large quantities of groundwater recharge. There are large regions where almost no groundwater recharge occurs, and much smaller areas where rather large amounts of recharge take place. Estimates as to how much of the total water available from rainfall actually becomes diffuse recharge range from a low of less than one inch per year in low-permeability glacial drift and Pennsylvanian shales to more than 8 inches in sandy alluvium in the Southeastern Lowlands. Although these values seem low, if the total area of the state is considered, the resulting volume of diffuse groundwater recharge is large. Assuming a statewide average diffuse recharge of 4 inches, diffuse recharge supplies about 4.85 trillion gallons of recharge per year, enough water to supply each of Missouri's 5.2 million residents 150 gallons of water per day for over 17 years.

Discrete Groundwater Recharge

Another more spectacular type of recharge occurs in many areas of the state, especially in southern Missouri. This type of recharge, called *discrete recharge*, occurs in Missouri in areas where the dissolution of limestone and dolomite bedrock has occurred. Discrete recharge is the localized, concentrated movement of water from land surface into the subsurface. It typically occurs where karst groundwater recharge features have developed. *Karst* is a term used to denote areas where the topography is mostly formed by the dissolving of soluble rock such as limestone and dolomite. Rainwater passing through the atmosphere absorbs carbon dioxide and becomes slightly acidic. Acidity increases as the water moves through the soil materials absorbing more carbon dioxide and organic acids. The water dissolves the limestone and dolomite as it moves through fractures, bedding planes, and pores in the carbonate bedrock; each drop of water removing a minute quantity of rock. The more rainfall that can be recharged, the larger the openings grow, and the deeper the circulation. Over time, karst features evolve such as sinkholes, losing streams, springs and caves.

Sinkholes are topographic depressions in the Earth's surface caused by the subsurface removal of soil and rock. They result where soluble bedrock is dissolved by slightly acidic groundwater and the dissolved materials, along with some of the remaining insoluble parts of the rock, are transported underground through solution-enlarged openings in the bedrock. A void is formed as the bedrock dissolves, and over time the opening enlarges to the point that the roof is unable to sustain its own weight and a collapse occurs. If the newly formed sinkhole is developed mostly in residual materials, it will likely have nearly vertical or overhung sides, and little or no bedrock exposed in the walls. Over time, erosion will erode material around the rim, yielding the more typical bowl-shaped depression. Some sinkhole collapses occur in bedrock, typically where the roof of an underlying cave or void space is too weak for self support (figure 9).

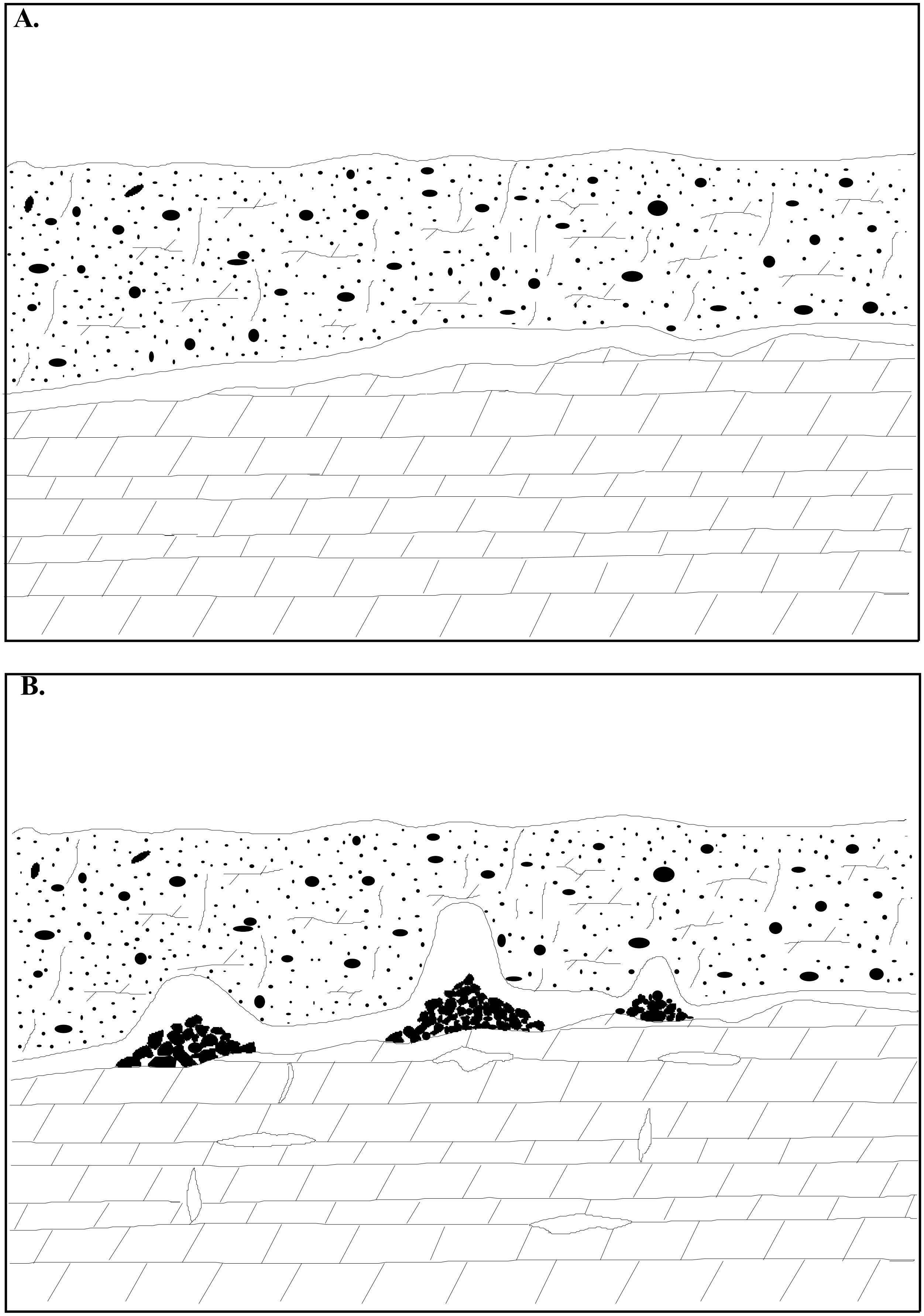
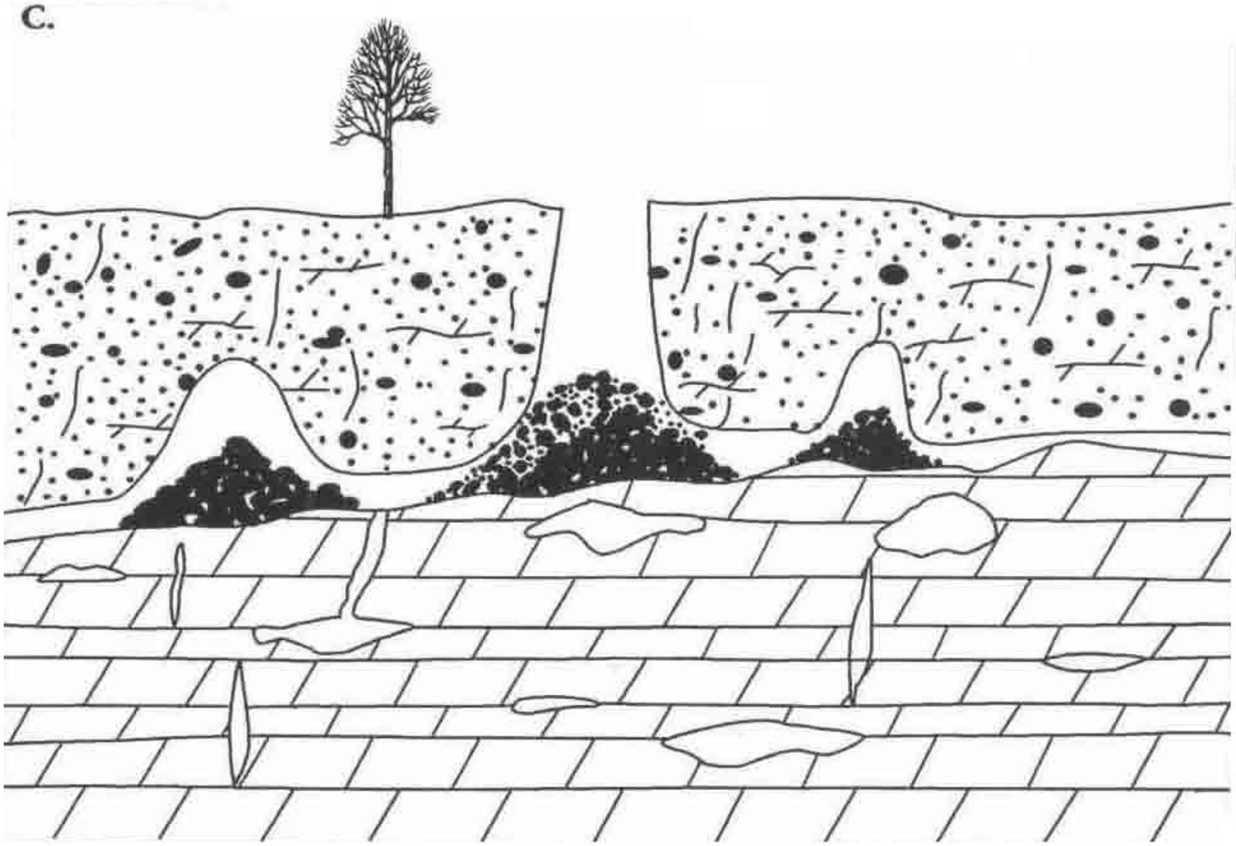


Figure 9. Stages of sinkhole development in residual materials.

C.



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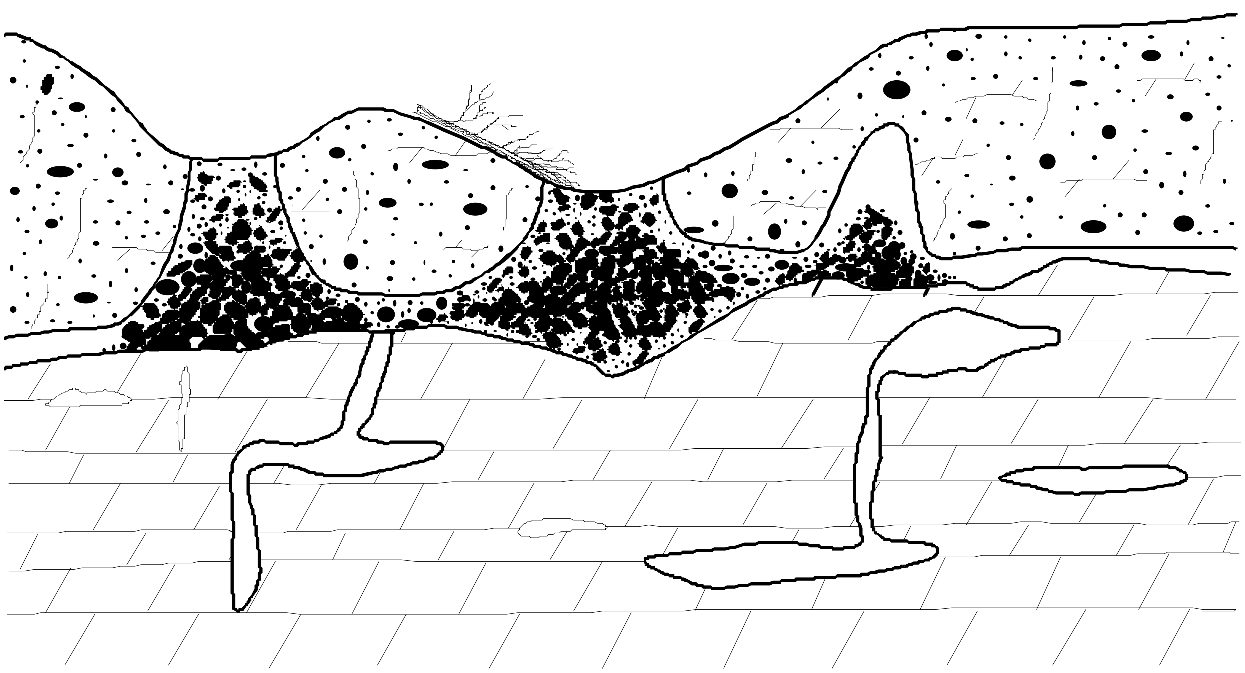


Sinkholes are discrete groundwater recharge features. They act as natural funnels, collecting and channeling underground the runoff that occurs within their catchment areas. Most sinkholes do not have large openings in their bases, but some are cave entrances. Even if large openings are lacking, the bottoms of most sinkholes are permeable enough to allow significant groundwater recharge. Unless a sinkhole fills completely and overtops, there is no surface-water outflow. Thus, all of the water entering the sinkhole from precipitation that is not evaporated or transpired is available for groundwater recharge.

Sinkholes range in size from depressions a few feet across and a few feet deep, to more than a mile in diameter and several hundred feet deep. Their drainage areas likewise vary greatly, from less than an acre to several square miles.

Streams that maintain flow essentially year-round and have flows that are well-sustained or increase in a downstream direction are called *gaining streams*. The water table along gaining streams is generally at or above stream level, and groundwater generally moves toward and into the stream. Losing streams are just the opposite. *Losing streams* are those that lose a significant part of their flow into the groundwater system. Like sinkholes, they are discrete recharge features that allow surface water to rapidly enter the subsurface. The water table along losing streams is below stream elevation. The water is generally lost into the subsurface through solution-enlarged openings beneath the streambed, openings that may be covered by gravel, sand, or other alluvial materials. Figure 10 is a photograph of Goodwin Hollow north of Lebanon in Laclede County. Although the stream drains nearly 70 square miles above this point, it seldom carries flow except after heavy or prolonged rainfall.

Unlike sinkholes, losing streams do not necessarily direct all of the water flowing in them into the subsurface. Also, a given stream can contain both gaining and losing reaches. Some streams have perennial or year-around flow in the upstream reaches while the valley farther downstream contains a losing reach and is typically dry. Others streams may lose flow in the upstream reaches but are perennial in the downstream reaches. A few losing streams have well-sustained flows throughout the losing reaches, but lose only part of the water. Some are essentially dry all of the time from headwaters to mouth. Few if any losing streams channel all of the runoff underground. Most losing streams will carry some flow after heavy, prolonged precipitation. However, even after very heavy rainfall, the flows of most losing streams decrease rapidly to zero within a few days after the precipitation ends.

Hydrologically, both losing streams and sinkholes can be thought of as the upstream ends or entry points of karst drainage systems. Springs are the groundwater outlets at the downstream end where the water lost underground through sinkholes and losing streams, as well as water provided by diffuse recharge, is returned to the surface. Connecting them are groundwater conduits, or cave-like openings, that can rapidly transport water through the karst drainage system. In the case of large springs, the conduits may be many feet in diameter and are essentially water-filled caves. Conduits feeding lesser springs may be little more than solution-enlarged fractures and bedding plane openings only a few inches across.

The volume of discrete recharge that occurs in Missouri each year is enormous. There are thousands of sinkholes and hundreds of miles of losing streams in the state. Most of these features are south of the Missouri River in the Ozark region, but a few significant karst areas extend north of the river, mostly in Boone County and counties bordering the Mississippi River downstream near Palmyra. Although the volume of discrete recharge is enormous, most of this water remains underground for only a short period of time, only a few days or weeks. Recharge through sinkholes and losing streams is rapid, and the groundwater conduits quickly transport most of the water to the receiving springs. Water tracing studies have shown that groundwater can move more than a mile per day through

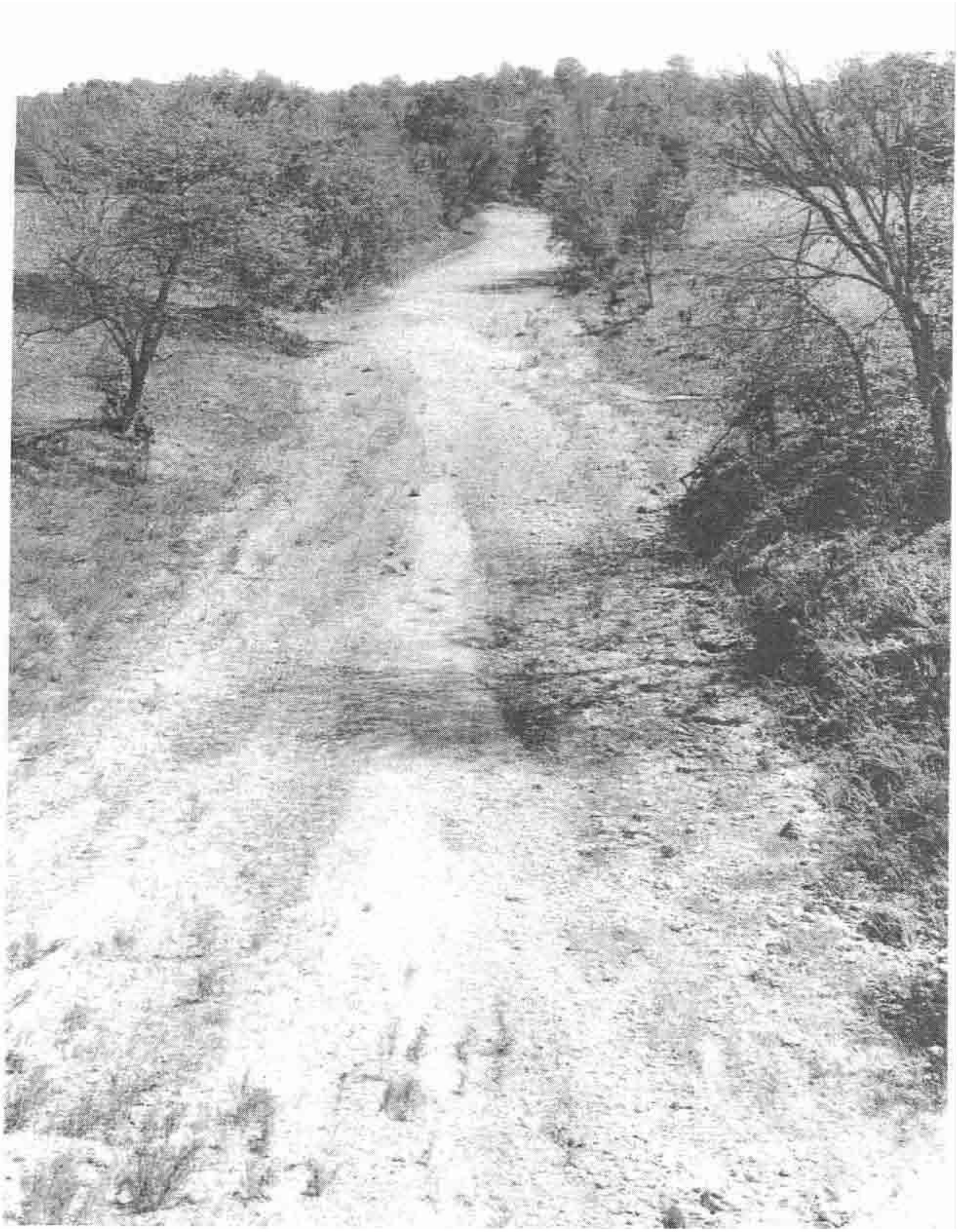


Figure 10. Goodwin Hollow is a major losing stream in Laclede County. Above this point, Goodwin Hollow drains more than 70 square miles but is typically dry due to water loss into the subsurface. Photo by Jim Vandike.

the karst groundwater systems. Water moving through karst drainage systems can be traced using several techniques, but generally fluorescent dyes are employed. To conduct a water trace, a fluorescent dye or other suitable substance is introduced into water where it disappears into the subsurface through the base of a sinkhole or in a losing stream. Springs and gaining streams in the area are monitored to determine where the tracing agent resurfaces. Water tracing allows a physical connection to be established between recharge and discharge points. It does not, however, show the actual path that the water followed during its journey.

Although most of this water does not remain underground very long, its importance should not be underestimated. At one time, springs supplied the drinking water for many people, and provided power to early industries such as gristmills, sawmills, electrical generators, and iron works. Today, few industries rely on springs for power, and most rural residents use wells for their source of drinking water or obtain water from rural water districts. A handful of towns still use springs to supply part of their water, but most use wells, reservoirs, or rivers. The value of springs today lies more in recreation and wildlife habitat. Springs are used extensively to supply fish hatcheries in Missouri, and provide habitat for trout. Without springs, the clear, cool Ozark streams that canoeists are so fond of would not be floatable most of the time. During dry weather, nearly all of the water in Ozark rivers and streams is from groundwater supplied through seeps and springs.

RESOURCE DESCRIPTIONS FOR MISSOURI GROUNDWATER PROVINCES

For the purpose of this resource evaluation, Missouri has been divided into seven groundwater provinces whose boundaries are similar to those of the physiographic provinces described early in this report. Among the factors considered in delineating the provinces were aquifer boundaries, aquifer types, groundwater quality, distinct geologic features and aquifer vulnerability to contamination. The geology and hydrogeologic characteristics of specific formations will be discussed, as well as the hydrogeologic characteristics of regional aquifers. In addition, groundwater storage estimates are presented for the various aquifers in each groundwater province.

The seven groundwater provinces used in this report are the St. Francois Mountains, the Salem Plateau, the Springfield Plateau, the Southeastern Lowlands, Northeastern Missouri, Northwestern Missouri, and West-central Missouri. The alluvial valleys of the Mississippi and the Missouri rivers are discussed as subprovinces, but are considered to be within the other groundwater provinces (figure 11).

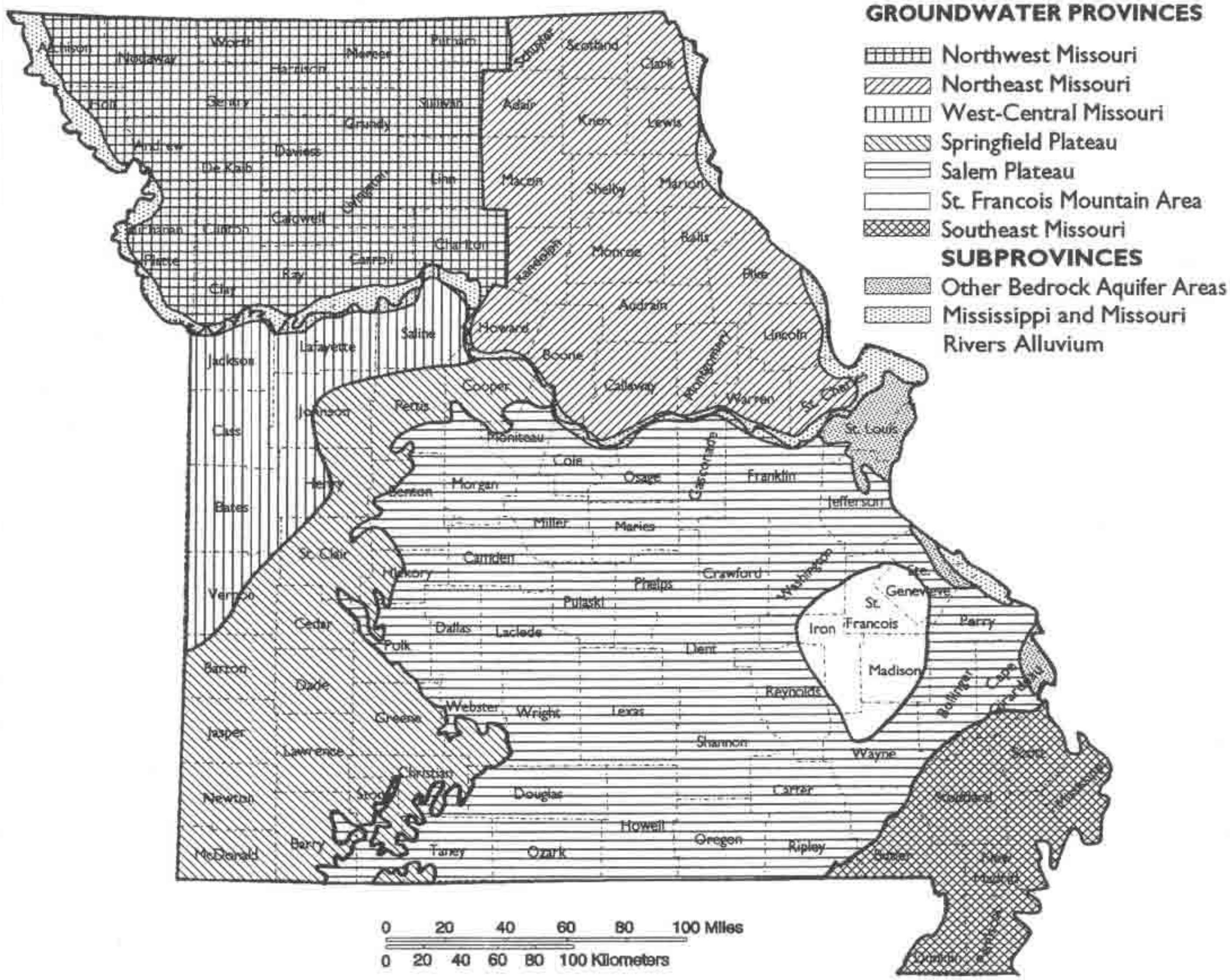


Figure 11. Groundwater provinces and subprovinces of Missouri.

THE ST. FRANCOIS MOUNTAINS GROUNDWATER PROVINCE

INTRODUCTION

The Ozark Plateau physiographic province covers most of southern Missouri and contains many of the states most prolific bedrock aquifers. The region can be subdivided into the St. Francois Mountains, the Salem Plateau and the Springfield Plateau, and will be discussed in that order.

The St. Francois Mountains province is structurally and topographically the highest point in Missouri. Rock outcropping in this area ranges from Precambrian igneous rock to Upper Cambrian-age clastic and carbonate units. The Precambrian igneous rock forms the core of the St. Francois Mountains, and the younger sedimentary units dip or tilt away from the core, becoming progressively deeper as distance from the St. Francois Mountains increases. Sedimentary rock formations cropping out in the St. Francois Mountains are a thousand feet or more deep in northern and western parts of the state. The province occupies an area of about 1,300 square miles, and covers all or parts of seven counties, including Iron, Madison, Reynolds, St. Francois, Ste. Genevieve, Wayne and Washington.

GEOLOGY

Deposition of sedimentary rock in the Ozarks began when seas transgressed over the Ozark region in the latter part of the Cambrian Period. Deposition was mostly a continuous process through the remainder of the Cambrian and the Lower Ordovician periods, with no major periods of emergence or interruption in deposition between individual rock units. Where one formation overlies another with no apparent pause in deposition, the units are said to be *conformable* with one another. In some instances, however, there are gaps in the geologic record that resulted from either nondeposition or deposition followed by erosion. These gaps or hiatuses in the geologic sequence are called *unconformities*. There are several major unconformities throughout the geologic record in Missouri. Such an unconformity exists between the Precambrian crystalline rocks and the overlying Cambrian strata. The time gap between the two is about a billion years.

The St. Francois Mountains form the core of the Ozark uplift, which was geologically active throughout most of late Cambrian time. When the entire midcontinent was covered by vast inland seas the Precambrian igneous and metamorphic rocks at the core of the uplift were emergent. Essentially, this emergent cluster of Precambrian rocks resembled islands of igneous rock rising above the level of the shallow seas that inundated this area. Over time, erosion attacked the emergent igneous and metamorphic rocks and generated large volumes of sand and igneous rock fragments. These clastic sediments were transported into the shallow seas. Coarser sediments were deposited closest to shore, particularly in the intervening basins between emergent igneous knobs. Finer sediments were carried farther from the source area. Limestone was deposited in deeper water away from the Precambrian highland as it was being destroyed by erosion. Eventually, the core was

eroded to a point that the seas covered the knobs, and younger sediments were deposited upon them. Later uplift of the Ozark Dome and subsequent erosion reexposed some of the igneous knobs. The uplift and subsequent erosion cycle also left the sediments around the perimeter of the knobs, dipping away from the uplift. Figure 12 is an idealized illustration of the geology and geomorphology of the Precambrian crystalline rock-Cambrian sedimentary rock relationship.

Table 3 is a detailed stratigraphic section of the rocks in the St. Francois Mountains groundwater province.

PRECAMBRIAN SYSTEM

The oldest rocks exposed in Missouri crop out in the St. Francois Mountains and are igneous in origin. Most of the exposed Precambrian igneous rocks consist either of rhyolites or granites (figure 13). The two are chemically similar, but the rhyolites are extrusive; they are chiefly volcanic ash-flow tuffs that formed when magma was extruded onto the Earth's surface and quickly cooled. The rapid cooling of the rock did not allow formation of mineral crystals. The granites, on the other hand, are intrusive igneous rock. They are much more coarsely-crystalline because they formed where magma was allowed to cool more slowly. Mafic igneous rocks, mostly diabase and basalt, intrude both the rhyolites and granites and occur as vertical dikes and horizontal sills.

Although they crop out mostly in the St. Francois Mountains in Missouri, Precambrian rock underlies all of Missouri at depth.

CAMBRIAN SYSTEM

Lamotte Sandstone

The Upper Cambrian Lamotte Sandstone is the oldest Paleozoic unit in the St. Francois Mountains. It crops out mostly on the northeastern side of the St. Francois Mountains, and forms the surface bedrock unit over an area of about 190 square miles. The unit rests unconformably on Precambrian igneous rock. The Lamotte is predominantly a quartzose sandstone that locally, particularly near its base, grades into arkosic sandstone or conglomerate. The sandstone itself can range in color from almost white through shades of gray, and in some places can be dark brown and even red. Locally, sandy dolomite and also reddish shale is present in the upper part at some locations. Arkosic sands are prevalent throughout the formation. Pebble conglomerates are locally distributed and not unusual in the lower one third of the unit. Weathered zones, which may indicate several phases of

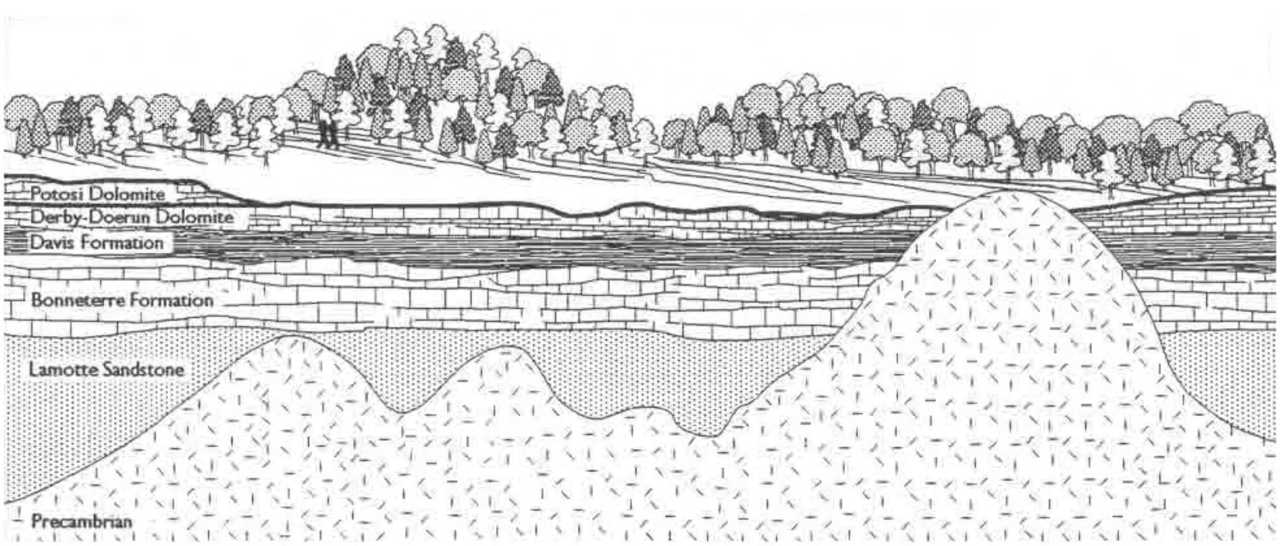


Figure 12. Idealized relationship between Precambrian igneous rocks and younger sedimentary rocks in the St. Francois Mountains area.

System	Series	Aquifer	Group or Formation	Thickness (in Feet)	Lithology	Hydrology
Cambrian	Croixian	Ozark Aquifer	Eminence Dolomite	0-150 Average 75	Similar to Ozark province. Deep fracturing has allowed extensive weathering of this unit.	Does not yield significant amounts of water in this province
			Potosi Dolomite	260-470 May be absent locally	Similar to Ozark province. Highly fractured and locally deeply weathered.	Small to moderate yield, 10-15 gpm
		St. Francois Confining Unit	Derby-Doerun Dolomite	45-160 Average 120	Similar to Ozark province. Chert-free dolomite with glauconite in lower part. May locally have gray-brown shale throughout.	Has poor water-yielding characteristics
			Davis Formation	75-200 Average 125 May be absent locally	Dolomitic shale, sandy dolomite, sandstone or limestone. Unit is highly variable.	Not an aquifer
		St. Francois Aquifer	Bonneterre Formation	175-535 Average 400 May be absent locally	Similar to Ozark province. Lower sandy phase may be replaced by interbedded dolomite and clastics. May rest on Precambrian where Lamotte is missing.	Yields small amounts of water to wells (3-20 gpm)
			Lamotte Sandstone	0-440	Similar to Ozark province. More arkosic near base with pebble conglomerates in lower third, also igneous fragments.	Yields 60-470 gpm Average yield 150 gpm
Precambrian		Basement Confining Unit	Igneous and Metamorphic Rocks			Not an aquifer

Table 3. Stratigraphic section of the St. Francois Mountains groundwater province.

deposition or changes in sea level during deposition, are not unusual to find. Locally, there are zones in the Lamotte that contain considerable igneous material. The material in these zones appears to be derived from nearby igneous intrusives into the Lamotte or from periods of more intense erosion and transport of material from adjacent Precambrian knobs.

In the interior of the St. Francois Mountains province (mostly in Iron, St. Francois, and Madison counties), the Lamotte occurs only sporadically, and the overlying Bonneterre Formation rests directly on Precambrian rock throughout much of the area (figure 14). Locally, the Bonneterre Formation is also absent, and the Precambrian is overlain by the Davis Formation.

The Lamotte Sandstone in this province ranges in thickness from zero to as much as 440 ft. Where it is thickest, the unit is composed of relatively clean sandstone, with very few zones of arkosic material, igneous fragment zones, shale, or dolomitic intervals. In areas where the unit thins, the Lamotte contains numerous intervals of these more exotic lithologies.

Yields of wells completed in relatively thick sections of Lamotte Sandstone in this province range from about 60 gpm to 470 gpm, and average about 150 gpm. Specific capacities are typically low, ranging between 0.5 and 1.5 gpm/ft.

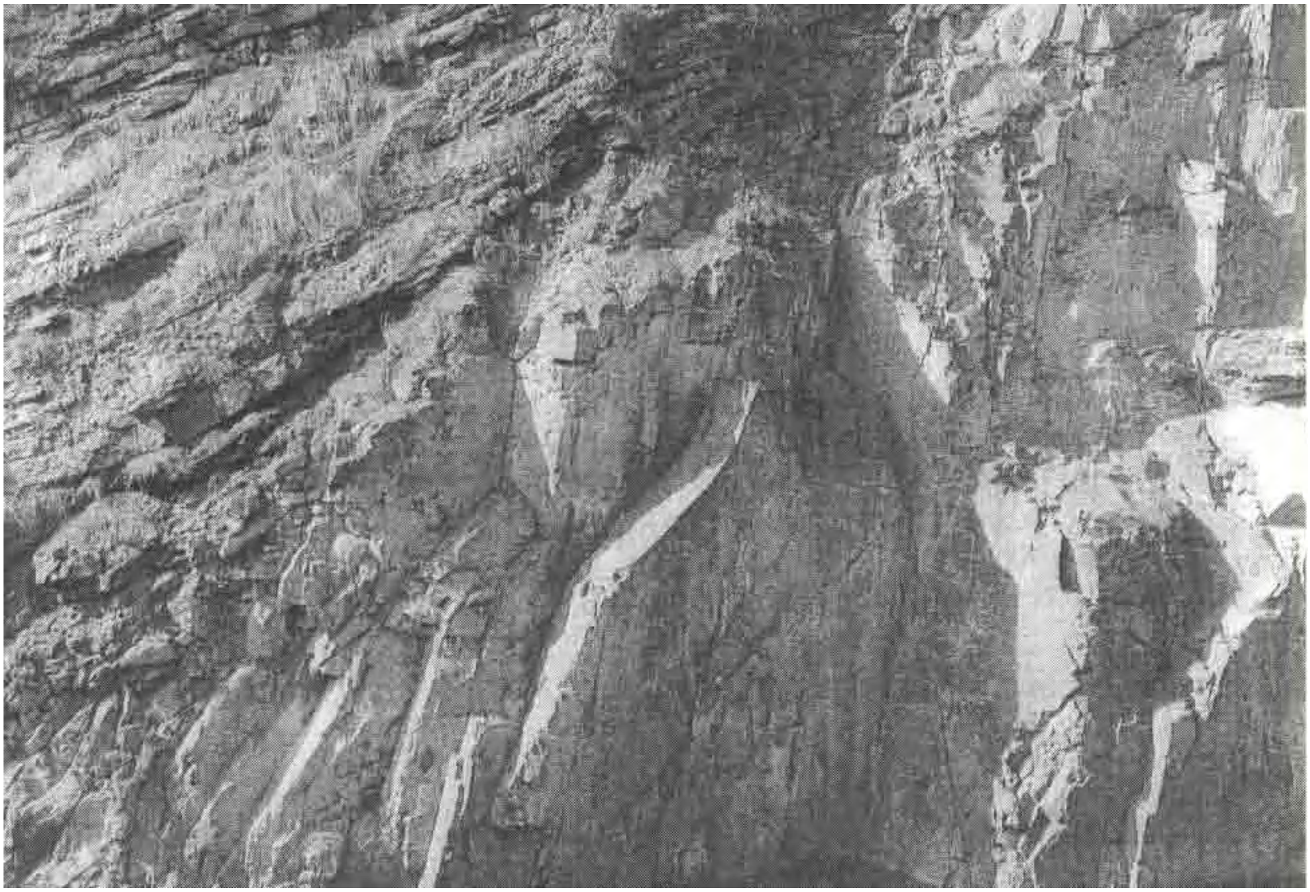


Figure 13. The contact between the Precambrian-age Taum Sauk Rhyolite and Upper Cambrian-age Davis and Derby-Doerun shaley dolomite in the St. Francois Mountains area near the Taum Sauk hydroelectric power plant. Photo by Jim Vandike.

The natural quality of water from the Lamotte is quite good. Typically, its total dissolved solids content is lower than water produced from the carbonate aquifers of the Salem Plateau groundwater province. Total dissolved solids range between 106 mg/L and 540 mg/L. Locally, there are areas of elevated radionuclides in this province, even though it is some distance from the freshwater-salinewater transition zone. Elevated radionuclides in the Lamotte Sandstone, including gross alpha, radium-226, and radium-228, are thought to be due to the natural radioactivity of certain igneous rock bodies whose weathered sediments form the arkosic parts of the Lamotte. The elevated radionuclides in water from the Lamotte occur locally throughout the eastern part of the province, particularly near the city of Fredericktown in Madison County.

Bonneterre and Davis Formations and Derby-Doerun Dolomite

In areas where the Lamotte Sandstone is present, the Bonneterre Formation conformably overlies it. However, the Lamotte is absent throughout a large part of the province and where it is, the Bonneterre rests unconformably on the Precambrian surface. It is in this area where the Lamotte “pinches” or thins to a featheredge against the Precambrian knobs, that mineral exploration companies find the predominance of lead mineralization, and where most of the major ore deposits have been found in Missouri.

The Bonneterre is a fine- to medium-crystalline dolomite and locally can be a limestone. In places it contains thin shale layers or partings, but typically is a carbonate unit with a low clastic content. In the Salem Plateau, and

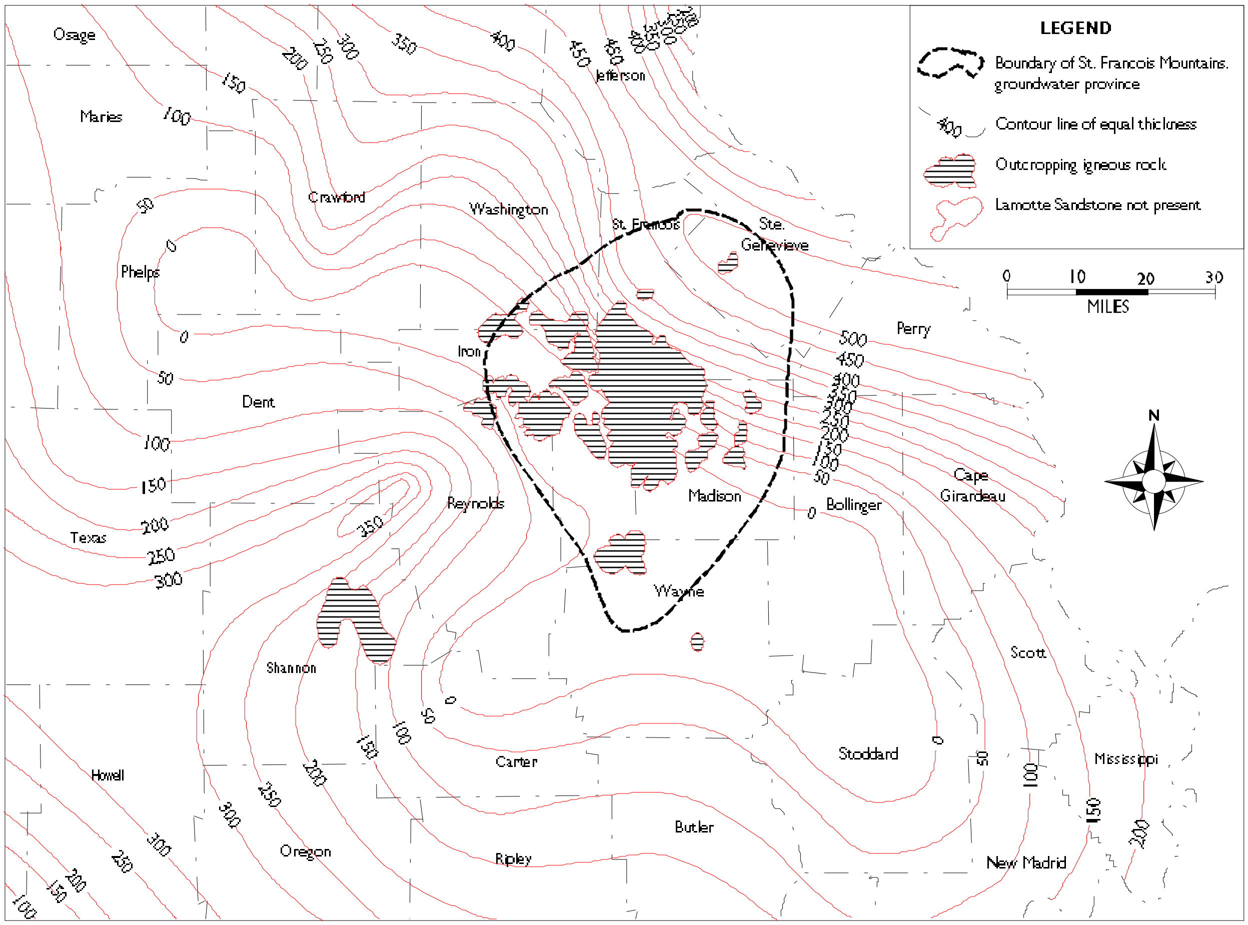


Figure 14. Isopach map of the Lamotte Sandstone in and around the St. Francois Mountains area (Bohm, 1981).

along the margins of the St. Francois Mountains, the lower Bonneterre appears to have a gradational contact with the Lamotte, containing alternating beds of dolomite and sandy dolomite. Sand content increases towards the base of the Bonneterre. Where the Lamotte is absent, however, this sandy transition is replaced by a zone of clastics and interbedded dolomite. The clastics were obviously derived from the weathering of the underlying Precambrian rocks.

The Bonneterre Formation ranges in thickness in this province from zero to 535 ft, and averages approximately 400 ft. There are areas around the margins of the individual basins within this province where the Bonneterre is extremely thin or missing. Here, the overlying Davis Formation may rest unconformably on Precambrian rocks. There is no obvious correlation between thickness of the Bonneterre and the presence or absence of the underlying Lamotte Sandstone. Where the underlying Lamotte is present, the lower 30 to 60 ft of the Bonneterre locally contains a depositionally restricted facies. This facies, known historically and informally as the Taum Sauk Limestone, is very finely-crystalline, chert-free, and red- to dark-reddish brown. The unit has been quarried in the past to provide terrazzo stone.

Yields of wells completed in the Bonneterre in the St. Francois Mountains province, are relatively small, ranging from 3 to 20 gpm. The relatively chert-free limestone and dolomite has a high enough silt and clay residue that when fractured, any secondary permeability which might be produced by fracturing is usually plugged before it can be solutionally enlarged.

The Davis Formation in the St. Francois Mountains province shows considerable vari-

ability in lithology from one locality to another, even within short distances. Locally, it can be dolomitic shale, sandy dolomite or nearly pure dolomite that is interbedded with shale, sandstone or limestone, all within an area of a few square miles. Such variation typically indicates multiple, rather restricted, depositional environments. The thickness of the Davis in this province averages about 125 ft, and ranges from 75 to 200 ft. There are areas around the margins of the individual basins within the province where the Davis, Bonneterre, and Lamotte are missing, and the younger Derby-Doerun Dolomite rests unconformably on the Precambrian basement rocks.

There are no data indicating that any well has ever produced appreciable groundwater from the Davis in this province. Where the unit is mostly shale, vertical and horizontal hydraulic conductivities are very low, but even where the unit is composed of a mix of dolomite and sandstone its hydraulic conductivity is still very low.

The Derby-Doerun Dolomite in the St. Francois Mountains province ranges in thickness from 45 to 160 ft, with the average thickness being approximately 120 ft. The lithology of the Derby-Doerun is a relatively chert-free dolomite with glauconite in the lower part. In many localities in this province, the unit also has significant amounts of grayish-brown shale throughout the formation.

The Derby-Doerun Dolomite is not a significant water-producing horizon in the St. Francois Mountains area. Where the unit is shaley, its permeability is greatly reduced. Even when the shale is absent, the rock exhibits poor water-yielding capabilities.

Potosi and Eminence Dolomites

The Potosi Dolomite, where present in the province, ranges in thickness from 260 ft to approximately 420 ft. It is not present in the restricted interior basins within the core of the Ozark Uplift; it occurs only near the outer boundaries of this province on the margins of the Precambrian knobs. The Potosi is composed of fine- to medium-crystalline, massive- to thickly-bedded, brownish-gray dolomite. The unit is usually “vuggy,” with small cavities filled with quartz druse. When freshly fractured, the rock has an oily or bituminous odor.

The Potosi has excellent vertical and horizontal hydraulic conductivity and fairly uniform lithologic character. Since it is typically shallow in the St. Francois Mountains area, it is often within the zone of groundwater level fluctuation, and may not be permanently saturated. There are no high-yield wells in the province that produce only from the Potosi. However, many private domestic wells that are drilled into the Potosi use it for water supply. The Potosi in this setting is much like the Roubidoux Formation over much of the Salem Plateau province. It provides ample quantities of water for domestic purposes, but is not a high-yield aquifer until it is at a greater depth, and is well into the saturated zone.

Overlying the Potosi Dolomite, and the youngest unit in this area, is the Eminence Dolomite. The Eminence has a limited occurrence and is found only around the extreme perimeter of the province. Where present, the average thickness is about 75 ft.

It is doubtful that the Eminence yields significant quantities of water to any wells in the province due to its limited distribution, relatively small thickness, and typically high topographic position. Even where deeply buried and thickest, the unit does not generally yield large quantities of water.

Both the Eminence and the underlying Potosi dolomites exhibit extreme fracturing and weathering in the St. Francois Mountains province. Stresses produced by uplift of the Ozark Dome throughout geologic time have caused significant fracturing and faulting in rocks adjacent to the major part of the uplift. This greatly increased the vertical and horizontal hydraulic conductivities in the rocks in and adjacent to these structurally deformed areas. Subsequent groundwater movement along these areas of high permeability has produced deep weathering profiles and correspondingly thick mantles of residual material (figure 15). A high percentage of domestic wells drilled into the Eminence and Potosi dolomites in this area experience problems with mud seams and pockets.

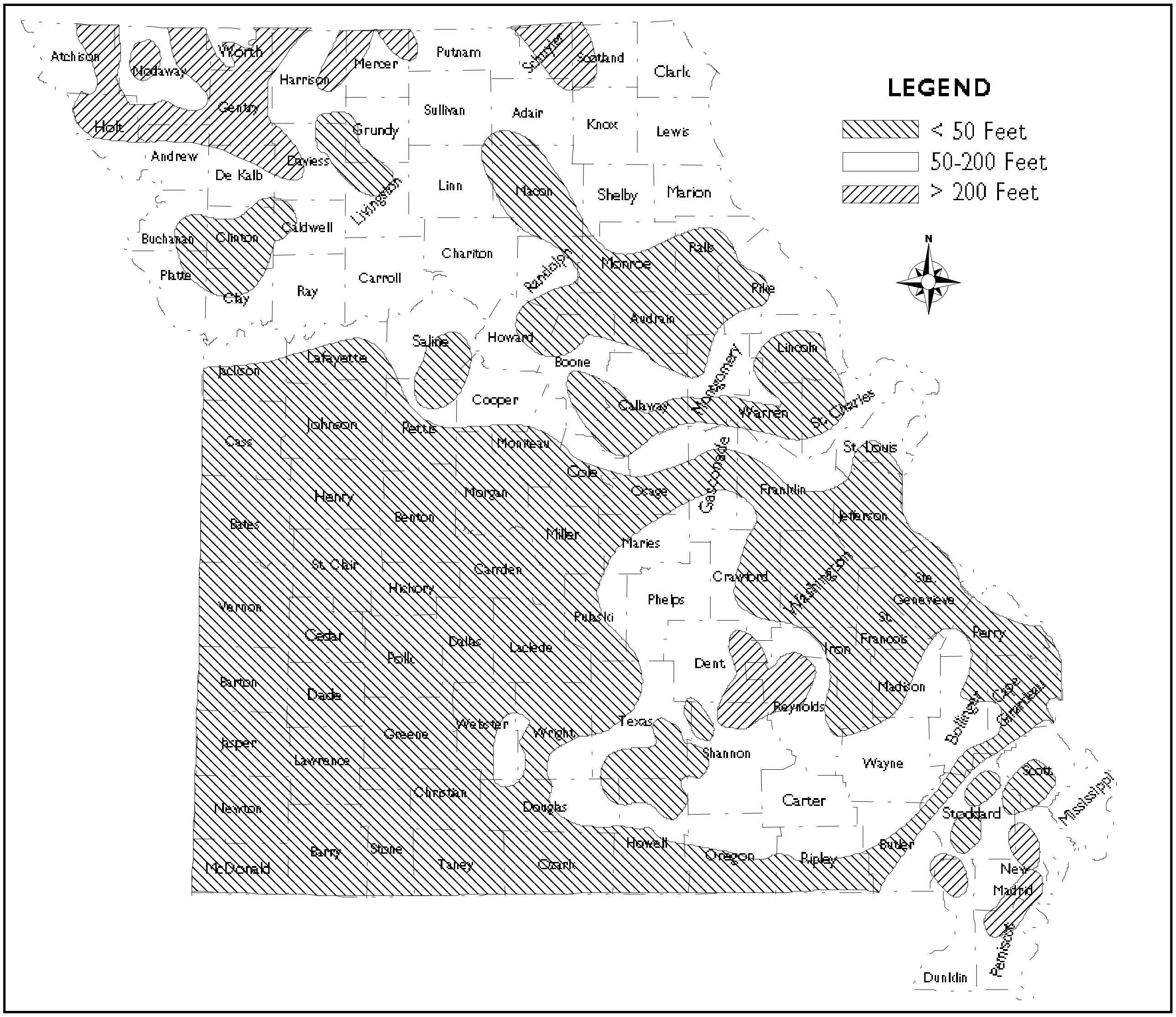


Figure 15. Generalized thickness of surficial materials in Missouri.

HYDROGEOLOGY

BASEMENT CONFINING UNIT

The Precambrian rocks in this region comprise the *Basement confining unit*. However, even though their permeabilities are generally very low, the Precambrian rock locally can yield small quantities of water. Groundwater production from the igneous rocks depends almost entirely on secondary permeability produced by fracturing. In some instances, where fractures are hydrologically conected with water-bearing zones in shallower, younger rocks or where the fracture intersects some sort of surface drainage, the basement rocks will yield small quantities of water to wells. Precambrian rock forms the bedrock surface over an area of about 390 square miles, mostly in Iron, St. Francois, and Madison counties. Where the Precambrian is the surface bedrock unit or is found at shallow depths, residents are forced to either attempt to construct a well, or depend on cisterns and hauled water for their supply. When groundwater is encountered in the drilling of a "granite" well, the yields are usually less than five gallons a minute.

St. Francois Aquifer

The major aquifer available in this area is the St. Francois aquifer, which consists of the Lamotte Sandstone and overlying Bonneterre Formation. It crops out over a nearly 600-square-mile area in the St. Francois Mountains region, and is present in the subsurface throughout the Ozark Plateau except for a few places where it was never deposited or it has been removed by erosion. The St. Francois aquifer is bounded below by Precambrian igneous rocks that form the Basement confining unit. In places, where the Davis Formation is present, it forms an upper confining unit called the *St Francois confining unit*. Locally, the St. Francois aquifer may be under water table or artesian conditions. Where present, it is used for private and public water supply throughout the St. Francois Mountains region, but is rarely used outside of the margins of this area.

The sediment-filled basins between the Precambrian knobs are the most reliable sources of groundwater in this province. The configuration of these basins, the saturated thickness of sedimentary rock deposited in them, and the lithology of the sediments are very important aspects to consider in determining the groundwater yield capabilities of proposed wells. In most instances, low vertical hydraulic conductivity greatly limits aquifer recharge. There is typically very limited horizontal circulation within the basins. Some appear to be hydrologically isolated with no obvious discharge points. The lack of groundwater circulation can cause an increase in the amount of dissolved solids. In other instances, adjacent basins are hydrologically connected, and groundwater moves between them. Wells drilled into the St. Francois aquifer in this area can locally yield as much as 400 gpm, but typically yield between 60 and 150 gpm.

The St. Francois aquifer in this province is estimated to contain about 919 billion gallons of usable groundwater in storage, or about 2.82 million acre-ft.

Ozark Aquifer

The Ozark aquifer in the St. Francois Mountains area is typically unconfined and consists of the Potosi and Eminence dolomites. It can locally exceed 600 ft in thickness, but in most places is less than 300 ft thick. Due to its relatively high topographic and stratigraphic position, its saturated thickness is generally considerably less than its total thickness, and well yields are correspondingly low. The unit supplies numerous private domestic wells in the province but is not generally capable of supplying large quantities of water.

GROUNDWATER CONTAMINATION POTENTIAL

In some ways, the St. Francois Mountains province may be the most critical area in the state in terms of the need for groundwater protection. Other areas may have greater population densities and greater volumes of groundwater in storage, but none rely so much on groundwater for rural water supply and nowhere else is the cost of constructing rural water lines higher. The value of a resource is generally greatest where it is the most scarce, and nowhere in Missouri is groundwater more scarce than in the St. Francois Mountains. Because of the thin soils and igneous bedrock, it is also the most difficult region in Missouri for laying water lines. Groundwater will probably continue to supply most rural residents for the foreseeable future. Although vertical permeability in this region is not particularly high, contaminants on the surface will eventually reach the groundwater. Very slow circulation and a relatively small volume of groundwater leads to long residence time for contaminants and minimal dilution. Waste treatment facilities, landfills, and other potential sources of contaminants should be carefully sited in this province to avoid adversely affecting groundwater supplies.

THE SALEM PLATEAU GROUNDWATER PROVINCE

INTRODUCTION

The Salem Plateau is the largest physiographic subprovince of the Ozarks region, and the Salem Plateau groundwater province is the largest in the state. As its boundaries are drawn for this report, this area includes all or parts of 49 Missouri counties, with a total surface area of about 24,760 square miles.

The Salem Plateau contains two major regional aquifer systems—the shallower Ozark aquifer and the deeper St. Francois aquifer. The St. Francois confining layer hydrologically separates the two. The characteristics of each of the geologic units in this province will be discussed in ascending order, followed by a discussion of the aquifers and aquitards comprised by the formations. Since karst development has played such a dominant role in the creation of this landscape and has so greatly affected groundwater conditions, it, too, will be discussed.

GEOLOGY

Bedrock geologic formations underlying this province range in age from Upper Cambrian through Pennsylvanian. The Salem Plateau surrounds the St. Francois Mountains and is bounded to the west by the Springfield escarpment, to the southeast by the Ozark Escarpment, and to the north and east by the Missouri and Mississippi rivers, respectively. Table 4 is a detailed stratigraphic section showing the geologic formations discussed in this description of the Salem Plateau.

CAMBRIAN SYSTEM

Lamotte Sandstone

The oldest sedimentary rock formation and the deepest aquifer zone in this province is the Lamotte Sandstone. The Lamotte is Upper Cambrian (Croixian) in age, and rests unconformably on Precambrian basement rocks. The amount of relief and slope of this unconformable surface assures that both the thickness and dip of beds in the Lamotte are unpredictable, particularly around the margins of the St. Francois Mountains groundwater province. Its thickness ranges from approximately 100 ft along the margins of the St. Francois Mountain groundwater province to more than 300 ft in the western and southern parts of the Salem Plateau groundwater province. It averages about 200 ft. in thickness.

The Lamotte is predominantly a quartzose sandstone that locally, particularly near its base, grades into arkosic sandstone or conglomerate. The sandstone itself can range in color from almost white through shades of gray, and in some places can be dark brown and even red. Locally, sandy dolomite is present in the upper part and in some locations reddish shale is also present. The Lamotte crops out in only a few places in the Salem Plateau, but, with a few exceptions, is present in the subsurface throughout the region. In western Madison County, parts of Phelps, Crawford, and Pettis counties, the Lamotte is missing and younger Cambrian sediments rest unconformably on the Precambrian surface.

System	Series	Formation	Thickness (In Feet)	Lithologic Character	Hydrology	Remarks
Recent		Loess & Residuum	0-300+	Windblown silt, and weathering products of limestone, cherty dolomite and dolomitic sandstone	Has fair permeability if materials jointed	Not a significant aquifer
Pennsylvanian		Undifferentiated Pennsylvanian rocks	0-100	Thin limestones, shales, siltstones, sand-stones, some coal beds	Small yields to wells. Water quality is usually poor	Locally a confining unit
Ordovician and Mississippian undifferentiated		Undifferentiated Formations	0-400	Various lithologies: limestone, shale dolomite, thin sandstones	Locally yield small amounts of water to wells (3-5 gpm)	Not a significant aquifer
Ordovician	Mohawkian	St. Peter Sandstone	10-100	Well-sorted, frosted, rounded quartzose sand, massive-bedded	Yields from 10 to 50 gpm	Ozark aquifer
	Whiterockian	Everton Formation	0-120	Sandy, silty dolomite; clayey, dark gray shale	Not a significant aquifer	
	Canadian	Cotter Dolomite	200 (Avg)	Fine- to medium-crystalline, cherty dolomite with numerous green shale partings; some thin sandstone beds	5 to 15 gpm locally	
		Jefferson City Dolomite	200 (Avg)			
		Roubidoux Formation	170 (Avg)	Cherty, sandy dolomite and dolomitic sandstone; oolitic	15-35 gpm where shallow, 50-75gpm where deeply buried	
		upper Gasconade Dolomite	40 (Avg)	Massively-bedded, coarsely-crystalline, chert free dolomite	Yields 50 to 75 gpm	
		lower Gasconade Dolomite	250 (Avg)	Very cherty dolomite, algal reef zones in upper part		
		Gunter Sandstone Member	25-30 (Avg)	Sandstone and/or sandy dolomite	40 to 50 gpm - normal yield 200 to 500 gpm locally	
Cambrian	Croixian	Eminence Dolomite	220 (Avg)	Medium to coarse-grained dolomite with low chert content	Moderate yields - 75 to 250 gpm	
		Potosi Dolomite	200 (Avg)	Fine- to medium-crystalline dolomite, with abundant quartz druse	Yields from 200 to 1000 gpm	
		Derby-Doerun Dolomite	150 (Avg)	Fine-grained dolomite in upper part, shaley near base with glauconite	Yields of 30 to 50 gpm available locally in upper part, usually not a significant aquifer	St. Francois Confining Unit
		Davis Formation	180 (Avg)	Shale, siltstone, fine-grained sandstone, limestone and dolomite conglomerates	Not water bearing	
		Bonneterre Formation	350 (Avg)	Fine- to medium-crystalline dolomite, sandy at base	Low yields, 10 to 15 gpm	St. Francois aquifer
		Lamotte Sandstone	100-300	Sandstone and dolomitic sandstone, Arkosic near base, locally absent	Moderate yields, 70 to 125 gpm	
Precambrian		Igneous & Metamorphic rocks				Basement Confining Unit

Table 4. Stratigraphic section of the Salem Plateau groundwater province.

In the western and southwestern part of the Salem Plateau groundwater province, the Lamotte grades into or interfingers with a unit that is lithologically similar but finer-grained and was deposited under depositional conditions different than that of the Lamotte. This unit, the Reagan Sandstone, is water-bearing and would likely yield at least modest quantities of water, but has not been used as an aquifer. Thus, very little is known about its hydrogeologic characteristics.

Bonneterre and Davis Formations, and the Derby-Doerun Dolomite

The Bonneterre Formation is Upper Cambrian in age and conformably overlies the Lamotte Sandstone. It is a fine- to medium-grained dolomite and locally can be a limestone. It often contains thin shale layers or partings, but typically is a carbonate unit with a low clastic content. However, in the lower part, it appears that there is a gradational contact with the Lamotte, with alternating beds of dolomite and sandy dolomite; the sand increases towards the base of the Bonneterre. The Bonneterre has an average thickness in the Salem Plateau groundwater province of approximately 350 ft.

Overlying the Bonneterre and conformable with it, is the Davis Formation, also of Upper Cambrian-age. The Davis is composed of shale, siltstone, fine-grained sandstone, dolomite, and limestone conglomerate. The sandstone and siltstone have a large percentage of glauconite. Flat-pebble conglomerates are common in the Davis, and are one of the unusual features that characterize the unit in the outcrop area. The Davis has an average thickness of about 180 ft in the Salem Plateau groundwater province.

Overlying the Davis, and conformable with it, is the Derby-Doerun Dolomite. The Derby-Doerun is also Upper Cambrian-age, and is similar in composition to the underlying Davis. The chert content of the dolomitic portion of the unit is usually less than 10 percent, but the glauconite is almost always confined to the lower part of the formation and the dolomitic section is almost always in the upper 50 to 75 ft. The average thickness of the unit in the Salem Plateau groundwater province is approximately 150 ft, although it may be absent locally.

Potosi Dolomite

The Potosi Dolomite of Upper Cambrian-age conformably overlies the Derby-Doerun Dolomite. The Potosi is composed of fine- to medium-grained, massive- to thickly-bedded brownish-gray dolomite. The unit is usually "vuggy," containing small cavities that are commonly filled with quartz druse. Freshly fractured Potosi dolomite will exhibit an oily or bituminous odor. The unit is present in the subsurface throughout the Salem Plateau groundwater province with the exceptions of the areas in the western part of the province where it becomes gradational with the overlying Eminence Dolomite. It forms the bedrock surface in the area of the province surrounding the St. Francois Mountains groundwater province, and in this area, it is most usually covered with varying thicknesses of dark-red, residual clay and chert. The Potosi ranges in thickness from less than 30 ft, to as much as 400 ft, averaging about 200 ft. As with all of the formations in the Salem Plateau groundwater province, it dips or tilts away from the St. Francois Mountains, and the unit is deeply buried towards the outer margins of the Ozark Plateau.

Eminence Dolomite

The Eminence Dolomite is Upper Cambrian in age, and was the last formation to be deposited in Missouri during Cambrian time. It conformably overlies the Potosi Dolomite in the Salem Plateau groundwater province, and in the southwestern part of the Ozarks seems to interfinger with the Potosi Dolomite. This interfingering causes a repetition of the lithologies. A well drilled in Wright County for the city of Mansfield showed several repetitions of Eminence and Potosi lithologies.

The Eminence is a medium- to coarsely-crystalline dolomite unit. The formation contains a relatively small amount of nodular chert in approximately the upper 100 ft, while the lower part of the formation is relatively chert-

free. The lower part of the formation, however, does contain sparsely scattered quartz druse that resembles druse found throughout the underlying Potosi Dolomite. The average thickness of the Eminence in the Salem Plateau is approximately 220 ft, and it attains a maximum thickness of about 350 ft in the south-central part of the Salem groundwater province.

Ordovician System

Gasconade Dolomite and Gunter Sandstone Member

The Gasconade Dolomite is oldest Ordovician-age formation in Missouri, and is subdivided into three units. The basal or lowermost unit that is formally recognized is the Gunter Sandstone Member. The Gunter ranges in thickness from 10 ft thick in the southern part of the province to almost 75 ft thick in the northern part. It has an average thickness of 25 to 30 ft. The contact between the Gunter and the underlying Eminence Dolomite appears to be conformable, indicating no significant break in deposition between the two formations. However, the lithologic change from a carbonate to a clastic signals a change in depositional environment and sediment source area. The Gunter is composed of varying amounts of sandstone or sandy dolomite. Throughout most of the Salem Plateau, the Gunter is mostly a sandy dolomite, but in a large area near the Lake of the Ozarks in Camden, Miller, and Morgan counties, the Gunter is a clean quartzose sandstone about 35 ft thick. A second area where the Gunter is a clean sandstone extends from Hickory County through western Ozark County along the west side of the province. Figure 16 is a map of the province showing sand percentages in the Gunter. In areas where the sand percentage is low, the Gunter may be difficult to distinguish from the underlying Eminence Dolomite or basal Gasconade Dolomite.

The Gasconade Dolomite above the Gunter Sandstone member is informally subdivided into the lower Gasconade Dolomite and the upper Gasconade Dolomite. The lower Gasconade Dolomite of Lower Ordovician-age (Canadian Series) is a light brownish-gray, very cherty, coarsely-crystalline dolomite. In some areas the chert content of the unit exceeds 50 percent of the total volume of

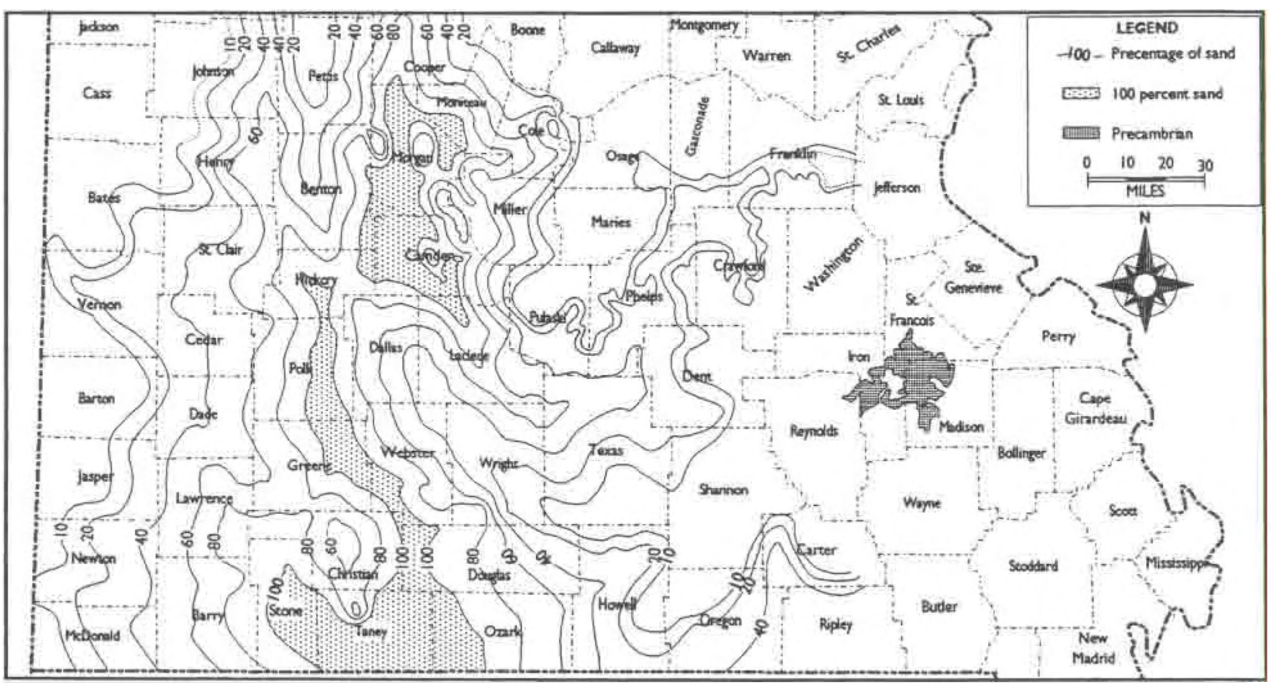


Figure 16. Lithofacies map showing sand percentages in the Gunter Sandstone Member in southern Missouri. (From Missouri Geological Survey and Water Resources, 1967.)

rock. The thickness of the lower Gasconade in the Salem Plateau groundwater province averages about 250 ft, but in the southeastern part of the province it thickens to almost 600 ft. Most of the Cambrian and Ordovician formations thicken as they dip or tilt to the southeast, into the Southeastern Lowlands.

The upper Gasconade Dolomite is a massively-bedded, medium-crystalline, light-gray dolomite that contains relatively small amounts of chert. Its thickness ranges from about 50 to 70 ft. The boundary between the upper and lower Gasconade is usually characterized by fossilized remains of large Cryptozoan algal reef masses. These algal reefs have been silicified, and now constitute massive chert beds that can be 10 to 20 ft thick. Because of its massive bedding, upper Gasconade typically forms cliffs where it crops out along valley walls. Its overall appearance, being relatively chert free, is in stark contrast to the very cherty, underlying lower Gasconade, and the very cherty, overlying Roubidoux Formation.

Roubidoux Formation

The Roubidoux Formation is Ordovician-age (Canadian Series), and consists of interbedded cherty dolomite, sandy dolomite and sandstone. In most places there is at least one sequence of sandstone in the Roubidoux, sandwiched between sandy and cherty dolomite. In some areas, however, there are two distinct sandstone sequences with cherty, sandy dolomite above, below, and between them. In a few locations, particularly in the Lake of the Ozarks area, the Roubidoux contains very little sand and is primarily a cherty dolomite.

The sandstone is composed of fine- to medium-grained quartzose sand that is usually rounded and frosted, much the same as modern beach sands. The cementing material binding the sand grains together is predominantly dolomitic, but there are areas where the sand is cemented by silica. On fresh, unweathered surfaces, the sandstone is creamy-tan to white. On weathered surfaces, the sandstone exhibits a range of color from brownish-gray, through all shades of brown, to yellow or even red. The dolomites are finely-crystalline, brownish-gray and usually cherty. Outcrops of the dolomitic beds of the Roubidoux in the Salem Plateau groundwater province typically contain abundant chert nodules and generally weather to a dull reddish-brown. The sandstone, however, is the lithology by which the Roubidoux is best typified.

Secondary permeability in the Roubidoux is typically high and was likely developed by three processes. Initially, the carbonate part of the formation was probably limestone, but was later dolomitized; the recyrstallization causes the volume of rock to decrease slightly, increasing permeability. The change in volume also affected the sandstone beds, causing fracturing in them. Finally, the formation was exposed to the effects of regional structural movement of the rocks, which caused additional fracturing.

Jefferson City and Cotter Dolomites

The Ordovician-age (Canadian Series) Jefferson City Dolomite conformably overlies the Roubidoux Formation and ranges in thickness in the Salem Plateau groundwater province from approximately 120 ft in the northern part to more than 350 ft in the southeastern part. Its average thickness is approximately 200 ft, and the formation generally underlies upland areas around the margin of the Salem Plateau. The Jefferson City is primarily a light-brown to tan, fine- to medium-crystalline, silty dolomite, with lesser beds of conglomerate, orthoquartzite, and shale. The shale is usually in the form of greenish-gray shale partings between the dolomite beds in the lower part of the formation. The unit has a lower chert content than the underlying Roubidoux. There is a conspicuous sequence of dolomite near the base of the formation where the dolomite is thickly- and massively-bedded. This zone has been used for dimension stone in the past, and is called the “Quarry Ledge.”

The Cotter Dolomite is also Ordovician-age (Canadian Series), and conformably overlies the Jefferson City Dolomite. In the Salem Plateau, the unit generally occupies only high topographic settings, typically along major drainage divides such as between the Gasconade River basin and the White River basin. It

has lithologic characteristics similar to the underlying Jefferson City, but typically has a higher chert content, and contains more interbedded shale and sandstone. The lower part of the formation is relatively chert-free, which makes identification of the formation boundaries difficult. The average thickness of the Cotter is about 200 ft, and its maximum thickness of approximately 400 ft is reached in the southeastern part of the province where the Cambrian and Ordovician rocks thicken as they dip beneath the unconsolidated sediments of the Southeastern Lowlands.

Both the Jefferson City and Cotter dolomites contain zones of finely-crystalline, silty, chert-free dolomite that weathers to a light-tan color. These dolomitic zones have been termed "cotton rock" because of their appearance.

The Jefferson City and Cotter dolomites are sometimes difficult to differentiate at the outcrop. They also exhibit similar hydrogeologic properties. For these reasons, the units are usually considered as a single hydrologic unit, and will be discussed as such in this report.

Everton Formation

The Ordovician-age Everton Formation (Whiterockian Series) is the oldest formation in the Middle Ordovician and rests unconformably on underlying rocks, typically the Cotter Dolomite. It is composed of sandy dolomite, with locally interbedded sandstone and cherty limestone, but locally can contain considerable siltstone and shale. The area of occurrence for the Everton in the Salem Plateau groundwater province is in the extreme eastern part of the province in southern Jefferson, Ste. Genevieve, Perry and Cape Girardeau counties. However, this formation is not always present in the subsurface in its area of occurrence. The Everton in this province ranges in thickness from 0 to as much as 120 ft.

St. Peter Sandstone

The St. Peter Sandstone is Ordovician in age (Champlainian Series). It rests unconformably on the underlying Everton Formation, and where the Everton is composed of sandstone the two units are difficult to distinguish from each other. Where it occurs, the St. Peter is from 10 to more than 100 ft of well-sorted, frosted and rounded, quartzose sand. The unit is predominantly silica, and in some areas is so pure that it has been extensively mined for silica for manufacturing glass. Unweathered exposures of the St. Peter are commonly pure white, with muted shades of pink and green. Weathered surfaces can be shades of brown, reddish-brown, and gray. The unit is massively-bedded, often with distinct bedding planes. Locally, the more massive beds exhibit cross-bedding, and ripple marks are not uncommon on bedding plane surfaces (Howe, 1961).

The St. Peter is present throughout the extreme northeastern and eastern part of the province. It crops out in a band from Franklin to Cape Girardeau counties, and is present at higher elevations in northern Gasconade County. Neither the St. Peter or Everton are regularly found in the northwestern part of the province. The exception being the localized occurrences of St. Peter preserved in paleo-sinkholes developed in the upper part of the Jefferson City and Cotter dolomites in Benton, Pettis, Cooper, and Moniteau counties.

Other Ordovician and Younger Formations in the Salem Plateau

Overlying the St. Peter Sandstone in the Salem Plateau groundwater province are several other rock formations. Their sequence of occurrence is highly dependent upon the area, and while they occur in one area, they may be missing in others. Mostly, they are present only in those areas where the St. Peter is present. They range in age from Ordovician through Mississippian and their combined thickness ranges from 0 to almost 400 ft.

Pennsylvanian Strata

Although not important as aquifers, Pennsylvanian-age rock in the Salem Plateau groundwater province have a pronounced effect on the quality of shallow groundwater in their outcrop area. Most of the Pennsylvanian strata in this area are shale or sandstone units. These rocks have a limited outcrop area

and form the bedrock surface at higher elevations in the northern part of the Salem Plateau groundwater province. In Osage, eastern Maries, extreme northern Phelps, northwestern Crawford, Gasconade, and western Franklin counties, the Pennsylvanian rocks rest unconformably on rocks of Lower Ordovician-age (mostly the Jefferson City and Cotter dolomites, but locally on the Roubidoux Formation). A small area in northeastern St. Louis County is also underlain by Pennsylvanian rocks. Pennsylvanian-age rocks are also preserved in paleo-sinkholes in several other surrounding counties to the west of the general outcrop area. Pennsylvanian rocks in the Ozarks are composed of fine- to medium-grained micaeous sandstone, clayey- to silty-shale, with thin, interbedded limestone.

In part of the outcrop area of the Pennsylvanian in the Salem Plateau groundwater province, fire clay deposits have historically been an important mineral resource. Fire clay was mined both south of the Missouri River, where Pennsylvanian strata unconformably overlie Ordovician rock, and in the Northeastern Missouri province north of the Missouri River in Callaway, Audrain, and Montgomery counties where the Pennsylvanian rests unconformably mostly on Mississippian rock. Pyrite (FeS) is locally associated with these deposits, particularly in the areas south of the Missouri River, where the deposits were of poor quality. Weathering and oxidation of the pyrite has locally caused an increase in dissolved iron and sulfate concentrations in shallow aquifer zones. High sulfate concentrations generally makes the water more acidic and corrosive to steel well casing and pump pipe. The high dissolved iron content in the water causes staining of laundry and plumbing fixtures, and the high sulfate content can give the water a bitter taste and cause intestinal problems. Casing is therefore used to exclude water from the Pennsylvanian strata in both private and public water supply wells in this area.

HYDROGEOLOGY

INTRODUCTION

Yields of wells drilled in the Salem Plateau are highly dependent on which geologic units are encountered, and at what depths. In some instances, depth appears to be almost as important as the aquifer unit in this area. If a geologic unit is deeply buried, so that it is below the point in the rock column where all of the cracks, crevices and open space are permanently saturated, then it will usually produce moderate to large volumes of water to a well. If that same unit is encountered at a shallower depth in the zone where water levels can fluctuate seasonally due to changes in recharge volume, then the yields may be relatively small. If the unit is at or near land surface in a setting in which the recharge water is in transition, and there is little or no permanently stored water, it loses its importance as a water supply source.

The effects that bedrock depths can have on water well yields is illustrated by examples in the Roubidoux Formation in the Rolla area. A 200-ft deep well drilled into the Roubidoux Formation in the Rolla area will yield about 20 gpm. Here, the Roubidoux is at a relatively shallow depth, generally above the depth where it is completely saturated with water. South of Rolla, the Roubidoux is at land surface, and in many places the water table is below the base of the unit. Thus, in this shallow depth setting, the formation is not considered to be an important aquifer. However, in the southwestern part of the Salem Plateau groundwater province near the Arkansas border, the top of the Roubidoux is at a depth of more than 800 ft. Here, the potentiometric surface is several hundred feet above the top of the unit, and yields range from about 100 to 150 gpm.

The presence of geologic structures also can increase permeabilities, especially where fracturing of the bedrock is prominent. The same fracturing can present problems due to rapid introduction of recharge water carrying bacteria. Figure 17 is a map of the Salem Plateau groundwater province, showing yields of the various aquifer zones by location within the province.

Groundwater quality in the Salem Plateau groundwater province is generally good, with the exceptions being the very localized elevated radionuclides and mineralized water. Groundwater quality degrades along the

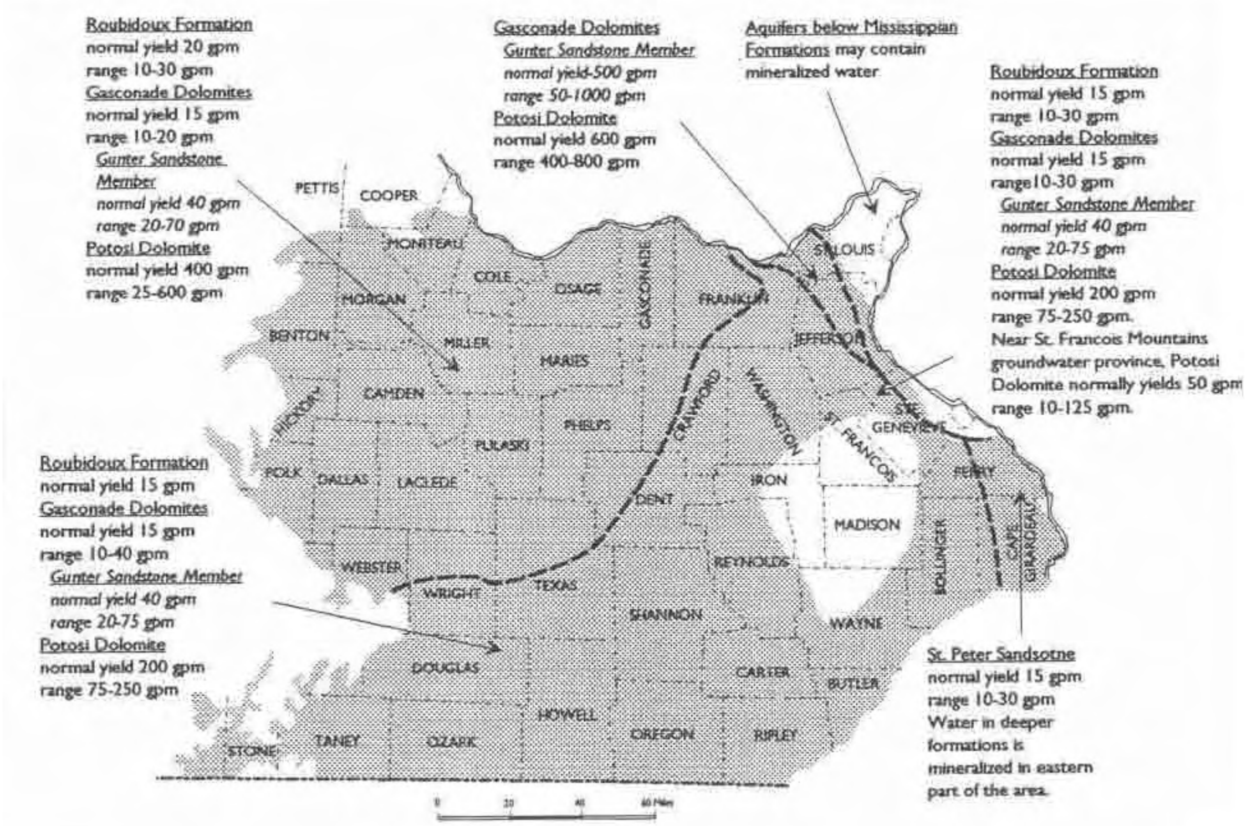


Figure 17. Yields of aquifers in the Ozark province (modified from Knight, 1962).

freshwater-salinewater transition zone along the eastern margin of the province and in the area in the north-central part of the province where shales and sandstones of Pennsylvanian-age are present. The Pennsylvanian rocks contribute waters which are high in both iron and sulfate. In most areas of the province, groundwater quality meets Missouri public drinking water standards with little or no treatment. The water is generally a moderately-mineralized calcium-magnesium-bicarbonate type. Chloride and sulfate are generally low except near the freshwater-salinewater transition zone.

St. Francois Aquifer

In the Salem Plateau, the Lamotte and Bonneterre formations comprise the St. Francois aquifer, which is the lowermost aquifer in the Ozark Plateau aquifer system. The St. Francois aquifer underlies all of the Salem Plateau, and almost everywhere is a confined aquifer. It is usually considered a moderate-yielding aquifer in this region. Of the two formations comprising the St. Francois aquifer, the Lamotte Sandstone is responsible for most of the production. The Bonneterre typically has a low hydraulic conductivity, and yields only modest quantities of water. Depth to the top of the aquifer ranges from less than 500 ft near the St. Francois Mountains, to more than 5,000 ft in extreme eastern Missouri in Perry and Cape Girardeau counties.

Total aquifer thickness varies from less than 100 ft near Precambrian igneous highs to about 1,100 ft at the edge of the Ozark Escarpment. Thickness averages about 500 ft across the Salem Plateau (figure 18).

The St. Francois aquifer is confined above and below by formations of low-permeability. The Precambrian rocks underlying the Lamotte form the *Basement confining unit*. The Davis Formation and Derby-Doerun dolomites overlying the Bonneterre Formation form the *St.*

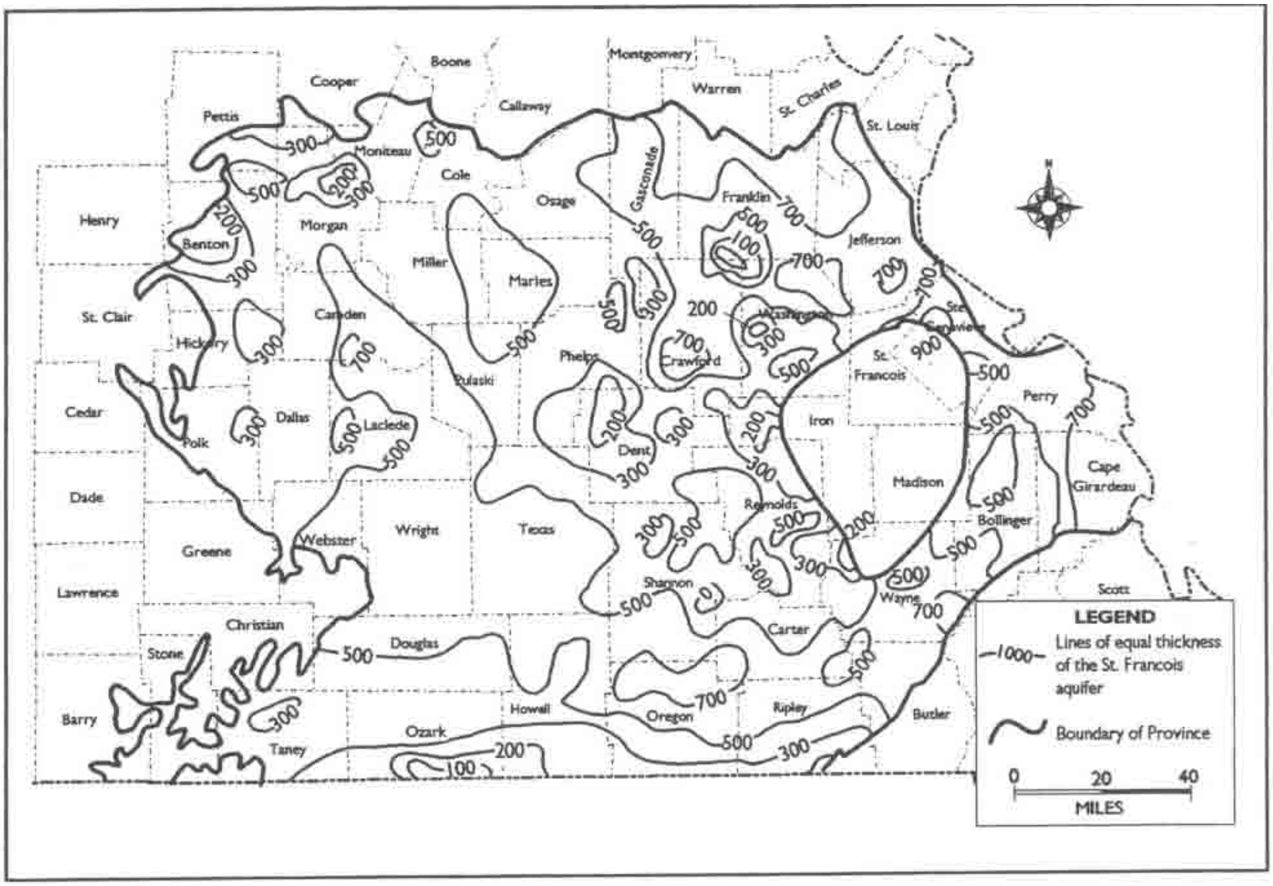


Figure 18. Thickness of the St. Francois aquifer in the Salem Plateau groundwater province (from Imes and Emmett, 1994.)

Francois confining unit. These confining units serve to separate the St. Francois aquifer hydrologically from the overlying Ozark aquifer. The presence of the St. Francois confining unit does not prevent water interchange between the two aquifers. It is, however, of low enough hydraulic conductivity that movement is greatly restricted.

The St. Francois aquifer, in the Salem Plateau, receives recharge from two general sources: down-dip movement of groundwater from the outcrop region in the St. Francois Mountains, and downward movement of water from the Ozark aquifer.

There are records of very few aquifer tests from wells producing only from the St. Francois aquifer, especially in areas other than the St. Francois Mountains. Thus, hydraulic conductivity and storativity information is scarce. Imes and Emmett (1994) used lateral hydraulic conductivity values of 1.6×10^{-4} ft/sec in the St. Francois Mountains area, and 8×10^{-5} ft/sec elsewhere, in developing a regional flow model.

Yields of wells producing from the St. Francois aquifer normally vary from 70 to 125 gpm. In areas like the eastern part of the Ozark province, adjacent to the east side of the St. Francois Mountains groundwater province, it is a very important aquifer because it is the only local source of groundwater available. Throughout much of the Salem Plateau, however, the St. Francois is not presently in use. The aquifer is penetrated by relatively few deep municipal wells. Most of the information on the Lamotte comes from mineral exploration borings where hydrogeologic information is normally not collected. A few towns in the province, including Rolla, Lebanon, and most recently Sullivan, have wells that are open to the St. Francois aquifer. However, the wells are also open to shallower aquifer zones, and the percentage of the total well yield provided by the St. Francois aquifer is rarely determined.

Several decades ago, before the hydrogeologic characteristics of the thick dolomite units in the Ozarks had been evaluated, it was commonly thought that only thick sandstones would yield the quantities of water necessary for municipal wells. Thus, the target zones for most of these wells were sandstone units such as those of the Roubidoux, Gunter, and Lamotte. Later, it was found that most of the production of these wells was from the dolomite units, and that production from the sandstones was generally minor in comparison.

Where both the Ozark aquifer and St. Francois aquifer are open to a well, it is possible that the Lamotte actually "robs" water from the shallower formations during non-pumping periods. The potentiometric surface of the shallower Ozark aquifer is generally above that of the Lamotte. Thus, there is the potential for down-hole water movement in the well bore when the well is idle.

Routine mine dewatering at several lead mines operating along the Viburnum Trend in Washington, Crawford, Iron and Reynolds counties accounts for much of the water produced from the St. Francois aquifer in the Salem Plateau. The Bonneterre Formation hosts the lead sulfide mineralization, and dewatering of the Bonneterre, while mining is occurring, causes the potentiometric surface of the St. Francois aquifer to decline several hundred feet in the mining area. In most cases, the St. Francois confining unit prevents drawdown from mine dewatering from affecting water levels in the overlying Ozark aquifer.

Locally, however, some dewatering of the Ozark aquifer has been experienced. One example occurred at the village of Bixby near the northern end of the Viburnum Trend. A large diameter ventilation shaft, referred to as Vent Shaft #50 by the Doe Run Company, was constructed about 1,000 ft northwest of the town. Such shafts are necessary for mine ventilation and generally do not cause problems. The vent shafts normally are not cased except through the surficial materials, and generally produce relatively small quantities of groundwater. Vent Shaft #50, however, encountered well-developed, solution-enlarged openings in the Potosi Dolomite. Inflow from the shaft into the Casteel Mine more than 1,000 ft below the surface was initially several hundred gallons per minute.

The additional inflow into the mine did not hamper mining operations; the water was simply pumped back to the surface with the rest of the mine water, and discharged into a surface drainage. However, it caused a significant water-level decline in the Ozark aquifer in the Bixby area. Most of the private domestic wells in Bixby were relatively shallow, less than 200 ft deep, and produced from a very permeable zone in the Eminence Dolomite at a depth of about 150 ft. The permeable zone was dewatered by the vent shaft, and most of the private wells, though not dry, would no longer support sustained yields of more than about 3 gpm. Doe Run Company contractors grouted the bedrock around Vent Shaft #50, reducing the volume of water draining into the mine through the vent shaft to 50 to 70 gpm, and deepened the affected private wells to depths of about 600 ft to increase their yield and bore storage. Once the vent shaft was no longer needed, the Doe Run Company plugged it to totally halt the down-hole movement of water.

A water-level recorder was installed by the Division of Geology and Land Survey on a private well near Vent Shaft #50 in late 1987 (figure 19). Data collected from this well documents the water-level decline (figure 20). Vent Shaft #50 was plugged on September 5, 1991, and almost immediately water levels in the Ozark aquifer in the area began recovering. Full recovery of water levels to pre-Vent Shaft #50 conditions took about three and one-half years.

The natural quality of groundwater contained in the St. Francois aquifer in the Salem Plateau is usually quite good, at least where the unit is used for water supply. However, since it is not widely used outside of the St. Francois Mountains groundwater province, its water quality throughout most of the region is conjectural. The water is usually of a calcium-magnesium-bicarbonate type with low total dissolved solids. Its hardness is typically considerably lower than waters from overlying dolomitic aquifer units. Total dissolved

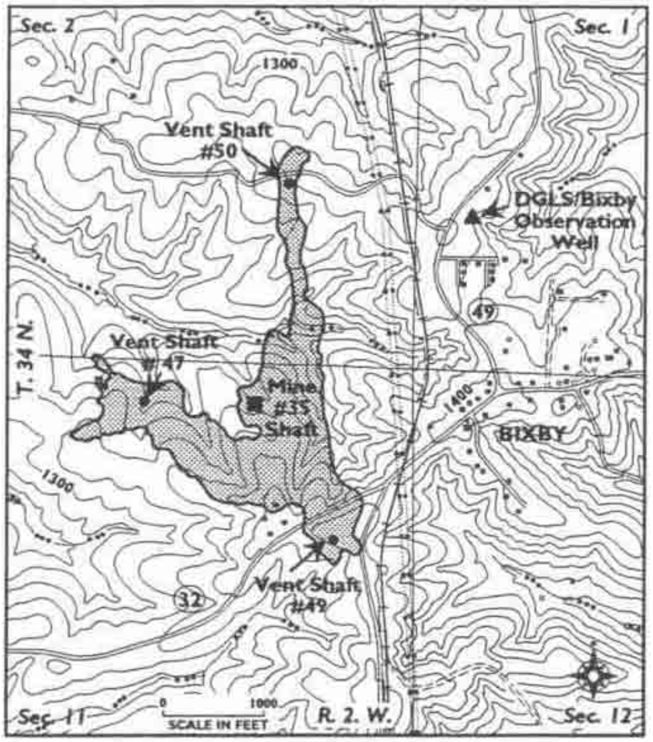


Figure 19. Location of Vent Shaft #50 in relation to Bixby and Bixby observation well. Shaded area is the approximate extent of Mine #35 (the Casteel Mine) in 1988.

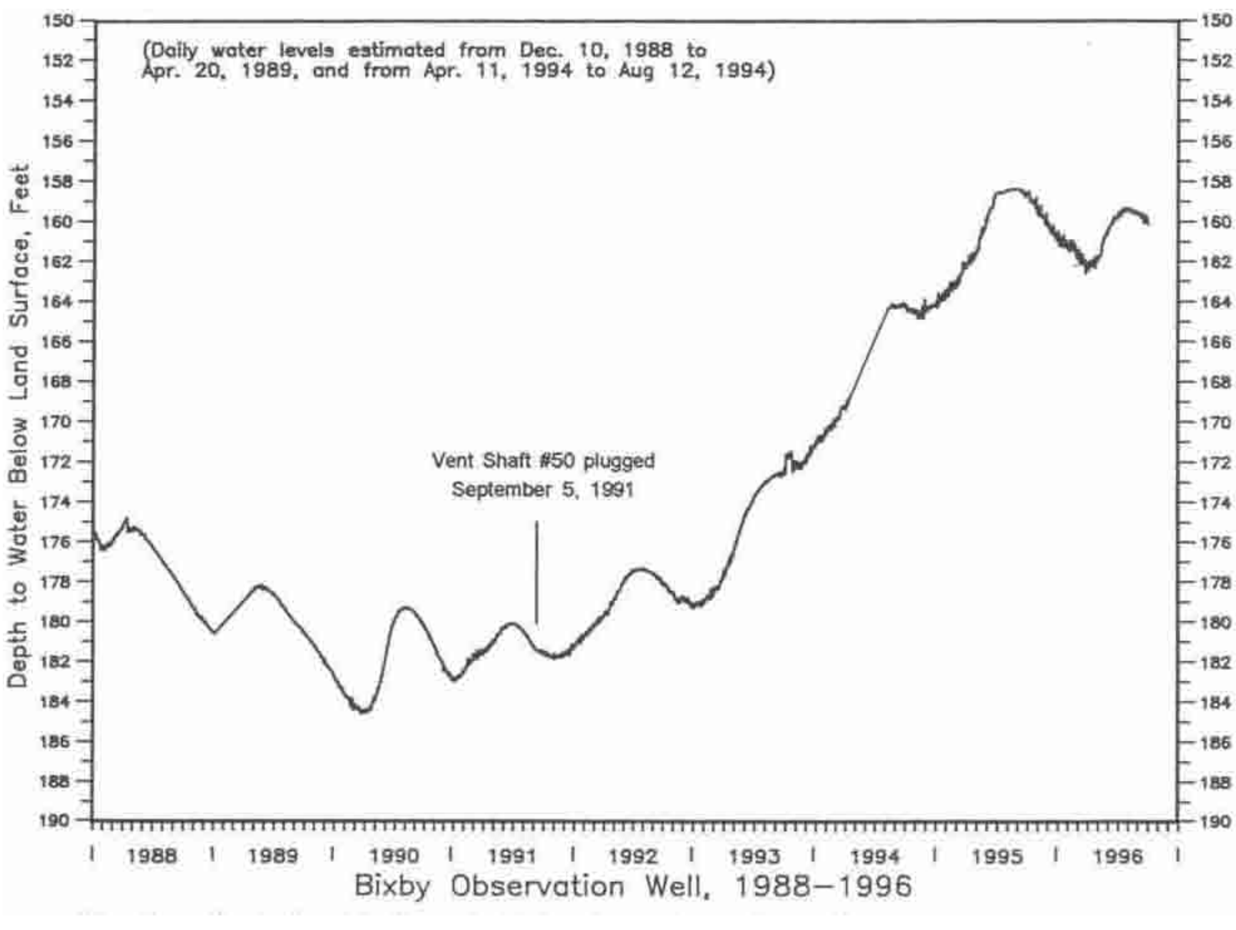


Figure 20. Groundwater-level hydrograph, Bixby observation well, Iron County.

solids likely increase greatly near the freshwater-salinewater transition zone, but data are not sufficient to substantiate this.

The Salem Plateau, along the St. Francois Mountains, has undergone periodic tectonic movement numerous times in the geologic past. The epeirogenic upwarping related to uplift of the Ozark Dome caused fracturing and faulting of the Paleozoic sedimentary rocks. Where the Lamotte has been extensively fractured, and those fractures filled with clay, water quality has suffered. In many instances, dissolved iron in the water may exceed 0.3 mg/l, the maximum recommended level for public water supplies. On the east side of the St. Francois Mountains groundwater province there are localized water quality problems caused by naturally occurring radionuclides. Gross alpha, radium-226 and radium-228 activities in this area are locally above the maximum levels that can be approved for public supplies. Currently these levels are 15 picoCuries per liter for gross alpha, 5.0 picoCuries per liter radium-226 and radium-228 combined.

In other areas of the state, higher concentrations of radionuclides are associated with geochemical reactions. Such reactions take place along the freshwater side of the freshwater-salinewater transition zone. The reactions appear to be controlled by the oxidation/reduction potential, which in turn may be related to elevated concentrations of hydrogen sulfide gas. However, this does not seem to be the case for the occurrence of high radionuclides in the Lamotte bordering the St. Francois Mountains. The freshwater-salinewater transition zone is some miles to the east, and there is no hydrogen sulfide present. In this case, the probable source of the increased radionuclides is the weathering of certain granites in the igneous complex of the St. Francois Mountains to the west. Small quantities of radioactive material derived from weathering of certain types of igneous rocks in the St. Francois Mountains were transported toward the east, and deposited with the sands of the Lamotte, probably in the lower, arkosic part of the formation.

Locally, the Lamotte is extremely fractured and the fractures can contain large quantities of silt and clay. This is also an area where the formation can have numerous thick shale sequences in the upper part. When wells encounter them, either of these conditions can cause a serious problem in the integrity of the drill hole, the total production of the well, and in the quality of the water produced. If the Lamotte is the only producing aquifer in the area, such problems may require abandoning the hole and choosing another well site.

Many private domestic wells are completed in the Lamotte Sandstone where it occurs at a shallow depth. Most of these supplies are located near the boundary between the Salem Plateau groundwater province and the St. Francois Mountains groundwater province where other aquifers are not available. Since a large volume of water is seldom needed for a private domestic well, most of them do not fully penetrate the Lamotte. Thus, yields of private wells producing from the Lamotte generally range between 25 and 40 gpm, and are typically much lower than those of fully penetrating, larger-diameter municipal wells. The Bonneterre is commonly used for private domestic supplies in the Ozark province adjacent to the St. Francois province where it is encountered at relatively shallow depths. Yields of 10 to 15 gpm are possible. The Bonneterre has a low chert content. Fracturing in chert-rich formations greatly enhances the permeability of the unit. The Bonneterre is a relatively pure dolomite or limestone, and fracturing does not seem to have greatly increased the secondary permeability, perhaps because it is more deeply buried and has not been subjected to karstification as have the shallower carbonate units. Yields of wells producing from the Bonneterre are therefore typically low, which greatly limits the formation's use. Although numerous public water supply wells are open through the Bonneterre, few if any produce only from it.

The St. Francois aquifer in the Salem Plateau groundwater province is estimated to contain about 23.7 trillion gallons, or about 72.7 million acre-ft of usable groundwater.

St. Francois Confining Unit

The St. Francois confining unit, which forms the upper boundary of the St. Francois aquifer throughout most of the Salem Plateau, consists of shale, siltstone, dolomite and limestone. Formations comprising the confining unit are, in ascending order, the Davis Formation and the Derby-Doerun dolomites. The St. Francois confining unit is saturated, but its hydraulic conductivity is generally so low that it yields little water. A notable exception to this is found in the area southwest of Lebanon in Laclede County near the town of Phillipsburg. Here, the Derby-Doerun Dolomite contributes 30 to 50 gpm to several public water supply district wells. In addition, the wells producing from the Derby-Doerun near the St. Francois Mountains yield modest quantities of water. In most areas, however, it yields little and is considered part of an aquitard.

The thickness of the St. Francois confining unit in the Salem Plateau range from 100 ft to about 500 ft, and averages about 200 ft. Shale content ranges from zero to about 30 percent, and averages about 20 percent (Imes and Emmett, 1994).

Ozark Aquifer

Undoubtedly, the most important aquifer in the Salem Plateau is the Ozark aquifer. Nearly every town, city, and rural water district produce most, if not all, of their water from this aquifer. It also is tapped by the vast majority of private domestic wells. The most water-productive zones within the aquifer are the St. Peter Sandstone, Roubidoux Formation, lower Gasconade Dolomite, Gunter Sandstone Member and the Potosi Dolomite. Although water-bearing and considered part of the aquifer, the Cotter and Jefferson City dolomites have relatively low hydraulic conductivity as does the upper Gasconade Dolomite.

The Ozark aquifer crops out throughout the Salem Plateau. Its thickness varies considerably due to erosion, generally ranging from 200 ft near the St. Francois Mountains to as much as 3,000 ft along the Arkansas border near the Bootheel. Normal thickness in most of the province is from 800 to 1,000 ft (figure 21).

The Ozark aquifer in the Salem Plateau is recharged by precipitation. Residual soils formed by the weathering of the mostly carbonate bedrock are very permeable. In addition, the surface and subsurface weathering of the carbonates has created numerous karst groundwater-recharge features such as sinkholes and losing streams that allow very rapid movement of water from the surface into the subsurface. Average yearly recharge rates vary from a few inches to as much as 14 inches per year.

Potentiometric measurements show a prominent regional groundwater divide in the Ozark aquifer that roughly trends east-west through the southern part of the Salem Plateau. Generally, hydraulic conductivities are higher north of the groundwater divide (Imes and Emmett, 1994).

The Potosi Dolomite is undoubtedly the most prolific and reliable aquifer zone in the Salem Plateau, and is the target unit of choice for many community public water supplies and other high-yield wells. Locally throughout this province, such as at Rolla, wells drilled through the Potosi yield 800 to 1,000 gpm. Because of the way that most wells are drilled in the Ozarks, with several aquifer zones open to the well, not all of the water is from the Potosi. Even so, yields from the Potosi likely range from 200 to 500 gpm. In its outcrop area, or in areas where it occurs at shallow depth, the unit yields only moderate amounts of water, generally 20 to 30 gpm. But where there is a significant thickness of saturated rock above it, yields increase dramatically.

The aquifer test depicted in Figure 22, city of Rolla's Hypoint Industrial Park well #2, shows the drawdown of the well over the period of the test plotted against time. Using standard pump-test analysis techniques, the transmissivity of the well was calculated to be 19,000 gallons per day per foot (gpd/ft). The higher the transmissivity, the better the water-yielding capabilities of the well. Table 5 shows transmissivities for wells penetrating the Potosi Dolomite at selected cities in the Salem Plateau province. In all cases, these wells also penetrate aquifer zones above the Potosi and water is produced from several zones.

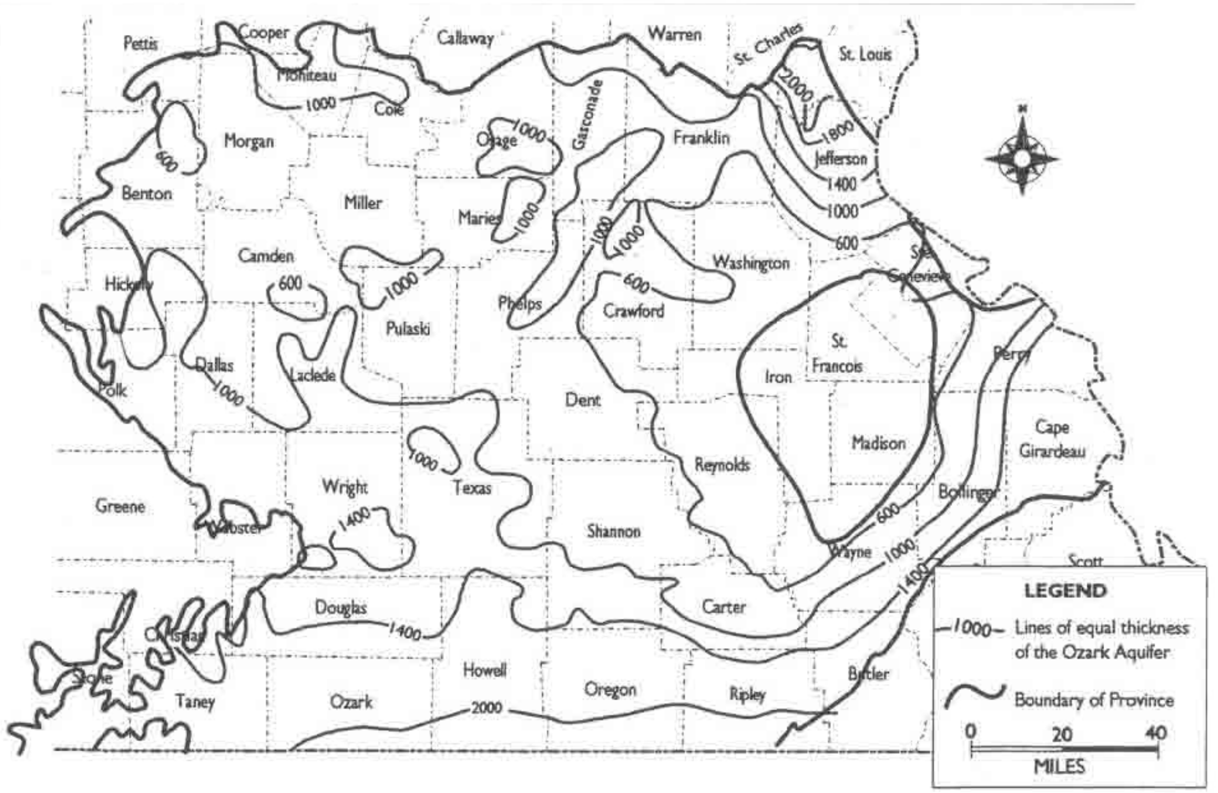


Figure 21. Map showing thickness of the Ozark aquifer in the Ozark province (modified from Imes, 1990).

Another measure of the ability of a well to yield water is its *specific capacity*. This is a measure of the gallons of water per minute being pumped, divided by the amount of drawdown produced by pumping (gpm/ft.). In most instances, Potosi wells yield almost twice as much water per foot of drawdown, as do wells finished in shallower aquifer zones.

Yields of 50 to 75 gpm are available from the upper part of the Eminence throughout the province, principally due to secondary permeability developed along fractures that are common in the unit. In areas where the formation is overlain by a relatively thick sequence of saturated rock, its yield usually increases. Yields from 150 to 250 gpm are not uncommon if the total thickness of the unit is used. One of the puzzling aspects of the Eminence is the fact that the unit usually shows a large amount of solutionally-enlarged fracturing, yet yields of water are fairly modest, as noted from the figures given above. Considering the thickness of the unit and the amount of secondary porosity from solution-enlarged openings, the Eminence should be a major water-yielding zone, but even where the unit is deep enough to be fully saturated it still yields only a maximum of about 250 gpm. Several factors probably contribute to the relatively low yields of the unit. The fractures, though abundant, may be discontinuous and may not have a high degree of interconnection. Evidence of this is found in the Current and Eleven Point river basins where there are numerous caves developed in the Eminence, and where most of the major springs discharge from the Eminence. Obviously, the Eminence in these areas contains bedrock openings large enough to channel flow to Missouri's largest springs, but yields of wells drilled into the Eminence near these same springs are not particularly high. The relatively low chert content of the Eminence could account for part of this. In other aquifer

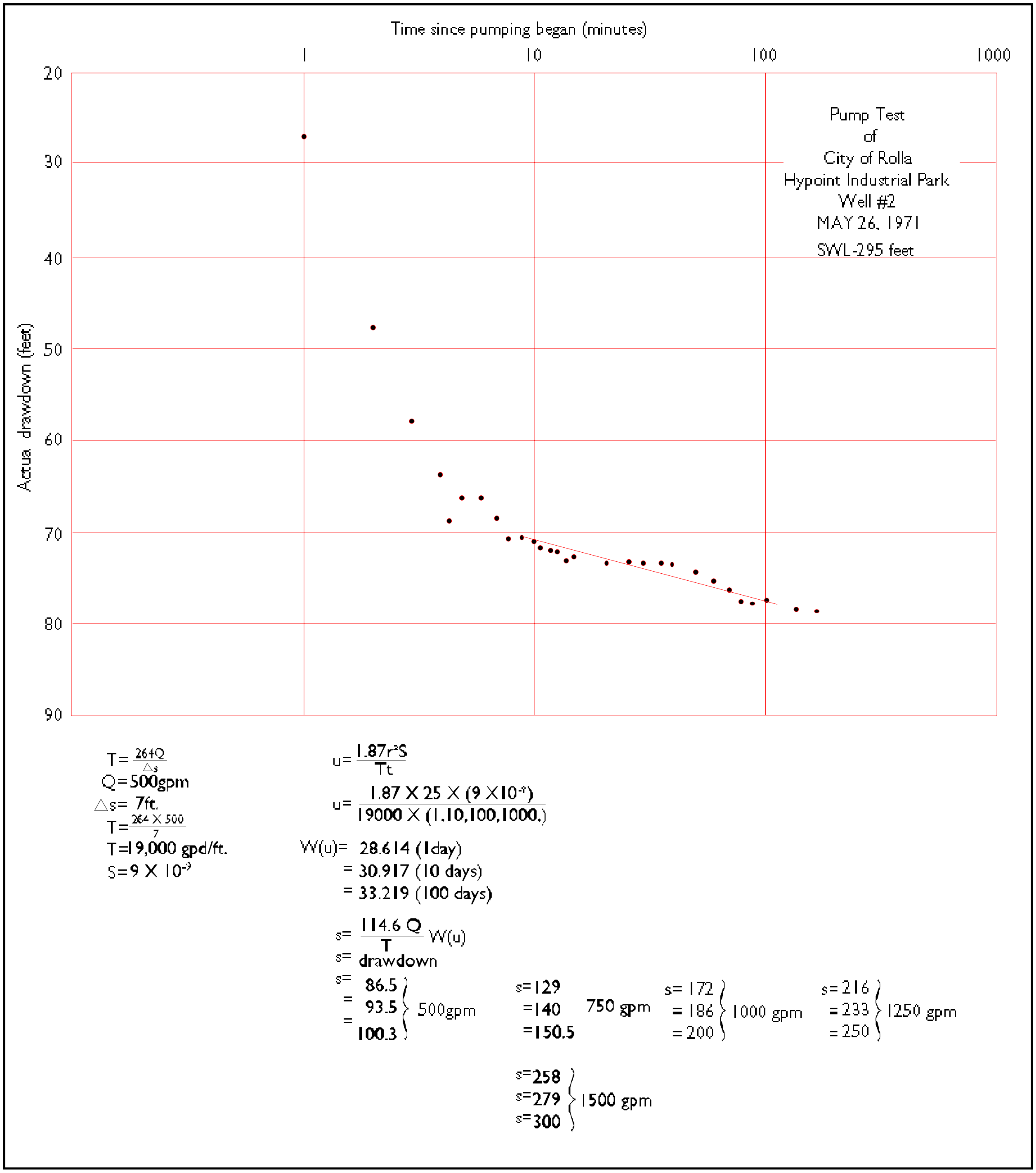
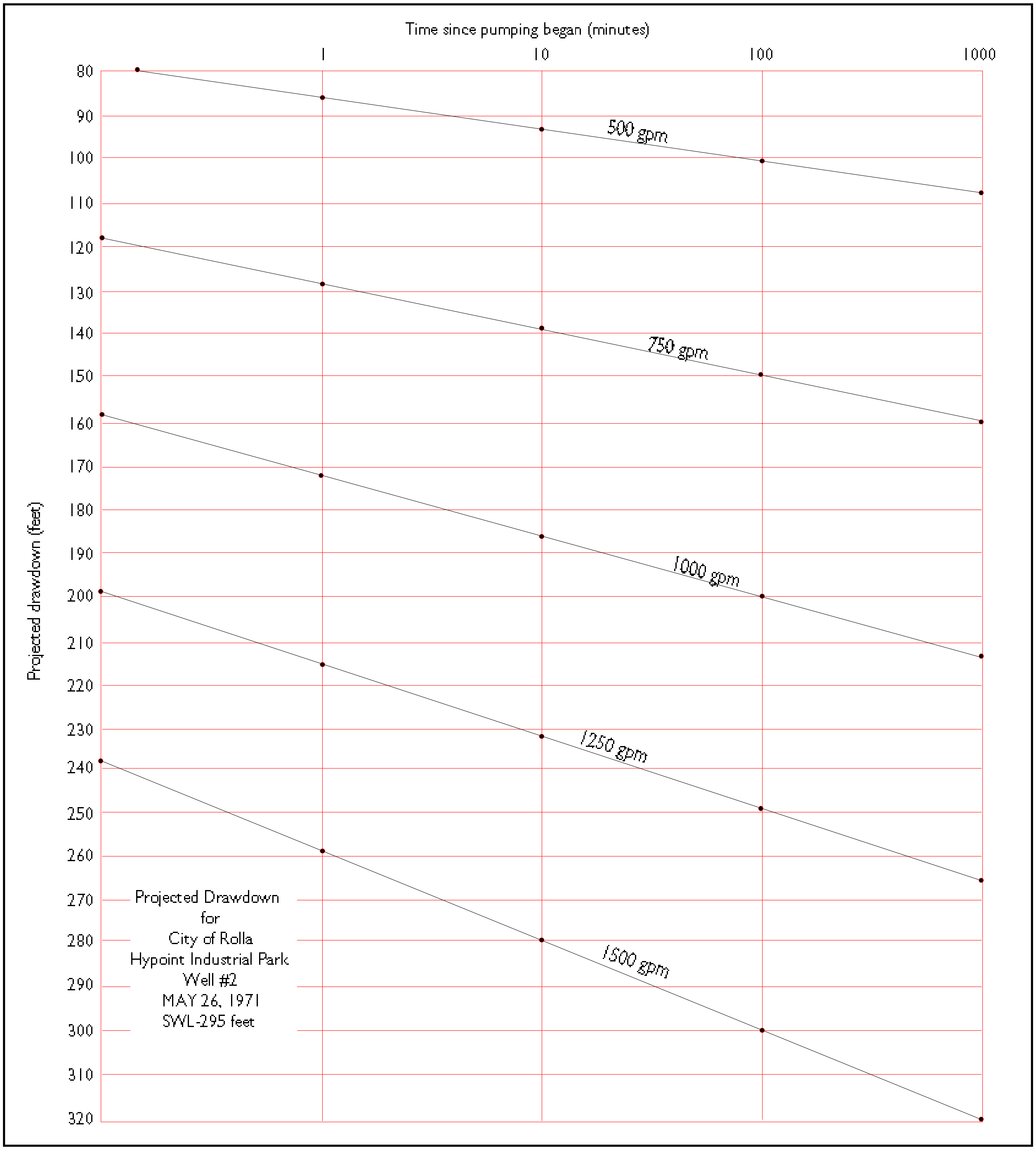


Figure 22. Pump test and time-drawdown projections for Rolla's Hypoint Industrial Park well #2.

units where chert is abundant, the chert fractures more cleanly than pure dolomite, and is less likely to be dissolved. The dissolution of dolomite not only produces residual material that can restrict groundwater flow if it is deposited in fractures, but the resulting poor circulation also can elevate the level of dissolved carbonate material that, if redeposited, can further restrict flow. Also, since chert beds lie in a horizontal plane, and fracturing is normal-

Figure 22 continued.



ly near vertical, the presence of thick chert zones could allow better interconnection between fractures.

Until about 1994, high-yield community wells in the Branson area in Taney County typically bottomed in the upper part of the Eminence Dolomite, and produced mostly from the lower Gasconade Dolomite and Gunter Sandstone Member. Typically, these wells yielded 300 to 500 gpm, and were from 1,100 to about 1,500 ft deep. Taney County is at the very western edge of the Salem Plateau groundwater province, and depth to the Potosi Dolomite here is considerably greater than in the eastern part of the province. At the time they were installed, the yields of these wells

Well Owner	County	Location Sec. T. R.	Yield (gpm)	Transmissivity gal/day/ft	Storage Coefficient (dimensionless)
Lost Valley Hatchery Well #1	Benton	04 40N 22W	450	4,604	1.6×10^{-4}
City of Camdenton Well #6	Camden	25 38N 17W	500	3,568	NA
Church Farm #7	Cole	18 45N 12W	100	573	2.0×10^{-4}
Cole Co. PWSD #1 Well #3	Cole	18 44N 12W	570	16,217	1.6×10^{-3}
MO State Penitentiary Well #2	Cole	08 44N 11W	260	5,280	1.5×10^{-3}
City of Cuba Well #4	Crawford	30 39N 04W	300	7,900	1.0×10^{-3}
City of Buffalo Well #2	Dallas	23 34N 20W	350	6,160	1.5×10^{-3}
Dent Co. PWSD Well # 1	Dent	29 34N 05W	150	1,460	NA
City of Sullivan Well #10	Franklin	10 40N 02W	200	2,400	NA
City of Union Well #2	Franklin	27 43N 01W	608	34,151	NA
City of Hermann Well #3	Gasconade	26 46N 05W	350	1,270	3.0×10^{-3}
City of West Plains Well #8	Howell	18 24N 08W	420	2,464	NA
Jefferson Co. PWSD #7 Well B	Jefferson	26 41N 04E	323	101,000	6.6×10^{-3}
Laclede Co. PWSD #1 Well #3	Laclede	12 33N 17W	140	3,800	2.0×10^{-4}
Laclede Co. PWSD #3 Well #6	Laclede	07 33N 18W	225	2,970	NA
City of Belle	Maries	21 41N 07W	145	2,000	1.0×10^{-3}
Ozark Co. PWSD #1	Ozark	18 22N 15W	150	5,800	2.0×10^{-3}
Tyson Foods Well #2	Pettis	22 46N 22W	950	7,838	2.0×10^{-3}
Rolla Industrial Park Well #2	Phelps	32 38N 07W	500	19,000	9.0×10^{-9}
City of St. James Well #4	Phelps	19 38N 06W	550	12,000	2.5×10^{-4}
City of Rolla Well #13	Phelps	07 37N 07W	802	13,233	NA
Ft. Leonard Wood Well #2	Pulaski	09 35N 11W	200	2,640	NA
Ft. Leonard Wood Well # 8	Pulaski	04 35N 11W	250	1,375	1.2×10^{-4}
Eastern MO Corr. Fac. Well #2	St. Louis	05 43N 03E	350	27,600	NA
Texas Co. PWSD #1 Well #2	Texas	27 33N 11W	180	2,500	NA
City of Licking Well #3	Texas	07 32N 08W	300	4,300	3.0×10^{-4}
Cabool Industrial Park	Texas	10 28N 11W	200	4,800	4.0×10^{-3}

Table 5. Hydrologic characteristics of selected Ozark aquifer wells in the Salem Plateau groundwater province.

were adequate to meet demands of the area and there was no need to attempt drilling into the Potosi Dolomite. In addition, data concerning depth, yield, and water quality of the Potosi were lacking, so there was some risk in attempting production from the deeper zone. Rapid growth in the Branson area in the late 1980s spurred interest in tapping into the potential of the Potosi, and in 1994, two wells with depths in excess of 2,000 ft were drilled. Both of these wells were considered successful. Yields in both exceeded 800 gpm and water quality was excellent. Since then, several other wells have been drilled into the Potosi in the Branson area. As this area continues to develop, it is likely that the Potosi will become an increasingly important target zone for groundwater development.

Since recharge to the Potosi is primarily from leakage or movement of water from shallower aquifer zones, there is very little difference in chemical quality between it and the shallower aquifer zones. Table 6 shows chemical analyses of selected municipal wells completed in the Potosi in the Salem Plateau groundwater province. However, since all of these wells are open to other water-producing formations, the water quality is not exclusively that of the Potosi Dolomite. Water quality from the Potosi is quite good throughout the Salem Plateau, except near the freshwater-salinewater transition zone in the northeastern part of the Ozarks province (figure 9). In this area, even water in some of the shallower zones can be locally mineralized. Throughout the Salem Plateau groundwater province, circu-

City Water Supply	pH	Alkalinity	Iron	Manganese	Sodium	Potassium	Calcium	Magnesium	Nitrate	Sulfate	Chloride	Fluoride	Total Dissolved Solids	Total Hardness	Copper
Cabool	7.6	238.	< 0.10	< 0.02	3.1	1.0	50.2	30.5	0.14	10.0	2.0	1.10	297.0	251.0	< 0.01
Desoto	7.3	279.	< 0.10	< 0.02	2.8	1.1	60.0	37.2	0.05	29.0	3.0	0.11	358.0	303.0	0.01
Festus	7.7	269.	< 0.10	< 0.02	4.8	1.6	62.8	33.2	0.05	25.0	3.0	0.39	313.0	294.0	0.01
Hermann	7.6	215.	< 0.10	< 0.03	3.1	1.8	42.1	25.8	0.05	15.0	4.0	0.16	244.0	211.0	< 0.01
Iberia	7.4	276.	< 0.10	< 0.02	1.9	1.6	60.0	34.6	0.05	13.0	2.0	0.20	329.0	292.0	0.01
Lebanon	7.6	207.	0.50	< 0.02	2.6	1.4	40.8	22.7	0.16	15.0	3.0	0.20	221.0	195.0	0.04
Licking	7.7	165.	< 0.10	< 0.02	1.7	1.2	35.0	19.8	0.14	10.0	2.0	0.10	208.0	169.0	0.01
Mansfield	7.6	211.	< 0.10	< 0.02	2.8	1.1	45.9	24.8	0.08	10.0	5.0	1.20	264.0	217.0	0.02
Rolla	7.5	277.	< 0.10	< 0.02	3.1	1.1	52.9	38.5	0.05	42.0	2.0	1.10	325.0	291.0	0.08
Salem	7.7	210.	< 0.10	< 0.02	2.2	0.7	42.8	25.1	0.38	< 10.0	2.0	< 0.10	251.0	210.0	0.01
Sullivan	7.9	141.	< 0.10	< 0.02	3.5	0.8	29.8	19.5	0.19	27.0	6.0	0.10	195.0	155.0	< 0.01
Washington	7.5	234.	< 0.10	< 0.02	2.3	1.1	35.8	33.9	< 0.05	15.0	3.0	0.10	248.0	220.0	0.02

Table 6. Chemical analysis of water from selected Ozark aquifer wells in the Salem Plateau groundwater province (from Department of Natural Resources, 1991).

lation of waters from shallower to deeper horizons is relatively rapid, and recharge from precipitation is continually moving fresh water through the flow system.

The Gunter is a target zone for many high-yield public water supply, irrigation and industrial wells in the Salem Plateau groundwater province. In some cases yield from the lower Gasconade Dolomite and Gunter Sandstone Member is ample to meet a particular need, but typically the well produces from other zones besides the Gunter. Many private domestic wells use the Gunter for water supply in the Lake of the Ozarks area of Camden, Miller and Morgan counties. Its shallow depth, moderate yield, and good water-quality makes it an excellent zone for private domestic wells. This is also the area where sand content is highest, and the unit is easy for local drillers to recognize. Yields of 15 to 40 gpm are not unusual from the Gunter in this area. In most instances where domestic wells use the Gunter for a water supply, higher-yielding community or noncommunity wells will have casing set and grouted to depths that exclude the Gunter. It is also possible, particularly in the Lake of the Ozarks area, for the Gunter to contain water which might be contaminated by private on-site waste disposal systems.

In most areas of the Salem Plateau, the Gunter Sandstone Member contains less than 30 percent sandstone, and is a sandy dolomite or dolomite. However, there seems to be no correlation between the sand content and well yields in the Gunter. In fact, yields of 400 to 500 gpm are possible in some locations where the Gunter contains only sandy dolomite.

The Gasconade Dolomite throughout most of the Salem Plateau groundwater province is the target zone for many wells. Wells drilled into the upper part of the lower Gasconade, have excellent reliability during prolonged drought periods. Yields of 50 to 70 gpm are possible from this sequence of rock where it is buried deep enough to be in the permanently saturated zone. However, where the unit is relatively shallow, it generally yields from 25 to 40 gpm. Although data are sparse, toward the outer boundaries of the province where the Gasconade is 700 ft below land surface or deeper, it may yield as much as 200 gpm.

Although the Gunter Sandstone Member and the lower Gasconade Dolomite are typically high-yielding zones, the upper Gasconade generally is not. Where appropriate, the casing of many high-yield wells is set to the base of the upper Gasconade. The hydraulic conductivity of the unit is not low enough for

it to be considered an aquitard, but it does have a substantially lower hydraulic conductivity than the lower Gasconade and the overlying Roubidoux Formation.

The Gasconade Dolomite crops out along most of the major valleys in the Salem Plateau and hosts many karst features including sinkholes, losing streams, caves and springs. Groundwater recharge commonly occurs at higher elevations where losing streams are developed in the Gasconade Dolomite. Where the Gasconade forms the valley walls and bottoms along major rivers, it typically hosts springs. Almost all of the first magnitude springs in the Ozarks discharge either from the Gasconade or Eminence dolomites. Many Ozark streams with well-sustained base flows, even during periods of drought, owe their flow characteristics to groundwater additions from the Gasconade. Where the Gasconade underlies upland areas in the Ozarks, it may host losing streams and sinkholes. Caves are commonly developed in the Gasconade Dolomite throughout the Salem Plateau.

The Roubidoux Formation is likely the most widely used single aquifer zone for private domestic water supply in the Salem Plateau. Thousands of private wells used for domestic and farm water-supply produce wholly or principally from the Roubidoux. Where the Roubidoux is deep enough to be permanently saturated, and is overlain by 100 ft or more of Jefferson City Dolomite, its water quality is generally not adversely affected by surface activities. However, where the unit is at or very near land surface, its saturated thickness may be insufficient to supply the needed amount of water during drought periods.

Yields of domestic wells 250 to 350 ft deep that are drilled into the Roubidoux, range from 15 gpm to about 35 gpm in the Salem Plateau groundwater province. Higher yields are more likely in wells drilled into the Roubidoux near the western and southwestern boundaries of the province. Here the formation is more deeply buried and permanently saturated, and normally yields 50 to 100 gpm.

The high secondary permeability typically found in the Roubidoux can be both a favorable and unfavorable characteristic. Where the Roubidoux is sufficiently deep to preclude the effects of surface activities, its high permeability makes it a good-yielding aquifer zone. However, where the Roubidoux is at or very near land surface, it can easily be affected by contaminants. Where the unit is exposed to the surface in upland areas it is often deeply weathered, and can contain mud and clay zones, openings and broken rock. This is particularly common in a large area of southeast Missouri extending from the Ozark Escarpment at the northern end of the Bootheel to near Rolla, and west to near U.S. Highway 63.

Losing streams are commonly developed where the Roubidoux Formation underlies valleys. Surface-water flow is lost to the subsurface in many stream reaches that cross the outcrop of the Roubidoux. Of all the losing stream reaches in the Ozarks, an estimated 60 percent of them are in areas where the stream channel is developed in the Roubidoux Formation (Bill Duley, 1995; personal communication). The water may resurface at a spring some distance downstream in the same drainage, or it may be diverted in the subsurface to a spring in an adjacent drainage basin. Interbasin transfer of groundwater through karst groundwater systems is common in the Ozarks.

Aquifer contamination in the Roubidoux is a local concern. Since the unit has relatively high vertical and horizontal permeability, and crops out over a large area of the Salem Plateau, the possibility of contaminants entering the formation and traveling for some distance is a distinct possibility. This type of aquifer vulnerability is a concern for all of the Salem Plateau groundwater province due to the degree of karst development, but the problem is more serious with the Roubidoux due to its hydrogeologic characteristics than with most other bedrock units. Contaminant migration in the Roubidoux depends greatly on the type of contaminant and the mechanism by which it was introduced into the subsurface. Water-soluble contaminants introduced into the Roubidoux through losing streams, sinkholes, or other discrete recharge features, will generally follow well-defined

flow paths through bedrock conduits. While the contaminant may cause serious water-quality problems at the spring where the water resurfaces, groundwater adjacent to the conduit between the spill site and spring is largely unaffected. Groundwater moves quickly through conduit systems, often more than one mile per day. Fortunately, once the contaminant sources are removed, water-quality normally improves quickly.

Contaminants from such things as poorly sited septic tank drain fields and lagoons in upland areas generally move more slowly when introduced into the Roubidoux in diffuse recharge settings. Depending on the degree of bedrock fracturing and the permeability of the sandstone beds, the contaminants may travel in a plume that increases in width and depth as distance from the contaminant source increases, or the contaminants may enter solution-enlarged fractures and follow a well-defined flow path. Because of slower groundwater velocities and lower recharge rates in diffuse recharge settings, contaminants introduced into the groundwater system here may cause longer-term groundwater-quality deterioration. In nearly all cases, contaminants that are not soluble in water will cause longer term groundwater-quality degradation, whether they are introduced into an aquifer through sinkholes or losing streams, or enter as diffuse recharge.

Although both the Jefferson City and Cotter dolomites are considered aquifer units, both typically exhibit relatively low vertical and horizontal hydraulic conductivities. They are not considered aquicludes, but can function locally as leaky aquitards. In upland settings where the Jefferson City and Cotter dolomites are the shallowest bedrock units, the amount of vertical groundwater movement through them into the underlying Roubidoux Formation is much less than where the Roubidoux forms the bedrock surface. Another indication of low vertical permeability in the Jefferson City and Cotter dolomites is the low-flow characteristics of streams flowing on them. Streams, which have their headwaters in upland settings where the Jefferson City and Cotter are the shallowest bedrock unit, typically gain flow or at least maintain flow to where they flow across the underlying Roubidoux Formation. At this point, many streams will lose flow into the Roubidoux, and except during periods of very wet weather, the reaches of streams on the Roubidoux will be dry for several miles. The streams may become gaining streams as they flow across the underlying Gasconade Dolomite. Ponds or small impoundments constructed in areas where the Cotter-Jefferson City is at the surface usually hold water, while the same structures constructed where a weathered Roubidoux Formation underlies the lake site may leak badly. Exceptions exist where the Roubidoux weathers to a plastic, clay-rich residuum. In these locations, water retention structures constructed in the Roubidoux are much less likely to leak. Water loss may also occur because of faulting or structurally induced fracturing of the rock units, which will not only cause the stream to lose water, but may also provide subsurface channels that route the water to some distant point of resurgence. Conversely, some faults are tightly cemented, which, instead of inhancing it, forms a barrier to groundwater movement.

The high topographic position that the Jefferson City and Cotter dolomites typically occupy, and their low hydraulic conductivities, combine to limit water infiltration, storage, and yield of water. Neither are considered important water-supply sources in most of the Salem Plateau. The exception to this is in the areas around the perimeter of the Salem Plateau where the units are thickest, and along topographic highs such as the interfluve between the White River tributaries and the Gasconade River in Wright, Douglas, Texas and Howell counties. Here, older private domestic wells locally produce from the Jefferson City and Cotter. The combined thickness of the formations in some of these areas exceeds 300 ft, and though yields are modest, generally 5 to 10 gpm, they are adequate to meet most domestic needs.

Two other geologic formations—the Powell and Smithville—are present at the ex-

treme northeast and southeast corners of the province and their geologic and hydrologic characteristics are very similar to the Jefferson City and Cotter dolomites. Because of their limited distribution, and their relatively poor water-yielding characteristics, they are not considered important aquifers. These units are, in ascending order, "Powell" Dolomite and Smithville Formation. They are conformable with the underlying formations and are the uppermost units in the Ordovician System (Canadian Series). Where the "Powell" and Smithville are relatively thick and water saturated, water yields are similar to those of the Cotter and Jefferson City.

Although water-bearing and capable in most areas of yielding modest quantities of water, the Everton is not considered important as an aquifer. In fact, the unit commonly presents problems for well drillers constructing wells into the deeper, high-production zones in the underlying Ordovician and Cambrian rocks. The Everton is composed of dolomite, sandstone and shale. Its heterogenous lithology sometimes makes it necessary for well drillers to set casing through the unit to prevent sediments from caving into the well bore and affecting the quality of the produced water. Where the Everton occurs at relatively deep depths, casing depths of more than 500 ft may be necessary.

The St. Peter is the uppermost aquifer zone in the Salem Plateau province that can reliably yield more than 10 gpm. Yields of 10 to 50 gpm are possible from the St. Peter where the unit is moderately thick. Many private domestic wells use the St. Peter for water supply in the eastern and northeastern parts of the Salem Plateau groundwater province where younger, shallower formations yield only very small amounts of water. This is especially true in those areas adjacent to the freshwater-salinewater transition zone where deeper bedrock aquifers yield highly-mineralized water. Where the St. Peter occurs at depths in excess of 400 ft and deeper aquifers yield good-quality water, high-yield public water supply wells are often cased above the St. Peter to allow it to contribute production to the well. The St. Peter has a very limited areal extent in the Salem Plateau, and is found only along the northern and eastern margins of the province.

Water quality in the St. Peter is generally good. Total dissolved solid content of water from the St. Peter is generally less than from the underlying carbonate rocks, and the water generally contains less calcium and magnesium, thus is “soft” compared to the deeper water. However, in the vicinity of the freshwater-salinewater transition zone, the unit locally contains water that is high in radionuclides. On the north and east sides of the freshwater-salinewater transition zone, it contains water with total dissolved solids in excess of 1,000 mg/L.

The Ozark aquifer in the Salem Plateau groundwater province is estimated to contain about 208 trillion gallons of water, or about 639 million acre-ft. This represents nearly 42 percent of Missouri's usable groundwater.

Other Aquifer Zones in the Salem Plateau Groundwater Province

Rocks younger than St. Peter Sandstone crop out in a band paralleling the Mississippi River in the extreme eastern part of the Salem Plateau groundwater province. South of the Ste. Genevieve fault zone in Perry and Cape Girardeau counties these include the Joachim Dolomite, Plattin Limestone, Kimmswick Limestone and several other Ordovician-, Silurian-, and Devonian-age rock units. Some of these formations do not yield any appreciable water while others may yield enough water to supply a private domestic well. Locally, the Joachim and Plattin can yield modest quantities of water ample for most domestic needs, but none of these units typically yield large quantities of water. North of the Ste. Genevieve Fault Zone, Mississippian-age strata form the bedrock surface throughout extreme eastern Ste. Genevieve and Jefferson counties, and throughout much of St. Louis County. Some Mississippian-age formations, including the Salem, St. Louis, and Burlington-Keokuk limestones, are capable of yielding several gallons of water per minute to domestic wells.

St. Louis County, though not generally considered part of the Ozarks, is discussed as part of the Salem Plateau groundwater province in this report. In extreme western and southern St. Louis County, the Ozark aquifer yields potable water; however, the quality of water in zones below the St. Peter Sandstone deteriorates to the northeast. The quality of water in the St. Peter remains potable for another few miles to the north and east, but then it too becomes too highly mineralized for use. In much of the central, eastern, and northern parts of the county, only the Mississippian-age limestones including the Burlington-Keokuk, Salem and St. Louis limestones, (collectively called the post-Maquoketa aquifer) yield usable quality water.

Groundwater-Flow Characteristics of the Ozark Aquifer in the Salem Plateau

The direction of shallow groundwater movement in the Salem Plateau is controlled by many factors. In the absence of karst development, flow in the shallower units is usually controlled by topography with the elevation of the potentiometric surface being highest along watershed divides and lowest along streams. In this instance, groundwater movement will be toward local drainage. Deeper circulation of groundwater is generally dependent on the regional dip of the rocks. Throughout most of the Ozarks, deeper flow is away from the structural center of the Ozark Uplift, or away from the St. Francois Mountains. The velocity and volume of groundwater flow is dependent on the vertical and horizontal hydraulic conductivities of the rock units, and the hydraulic gradient.

Although primary permeability accounts for some groundwater movement, secondary permeability provided by faulting, jointing, fracturing and the dissolution of carbonate rock has had a far greater impact on present day hydrologic conditions in the Salem Plateau. Most of the rock units in the Salem Plateau are composed primarily of dolomite. However, not all dolomite units readily develop appreciable secondary permeability, and some zones or formations transmit water at faster rates than others. The rock units that have developed considerable secondary permeability become important aquifers where they are deep within the saturated zone. Areas with thick mantles of residuum appear to have higher recharge rates than those with lesser thicknesses. The storage capacity of thick residuum is relatively high, and this helps to provide more sustainable recharge to the underlying bedrock aquifer zones than in areas where the residuum is thin.

Regionally, the Ozark aquifer in the Salem Plateau is considered unconfined since it does not have a confining unit overlying it. However, several characteristics of the aquifer cause it to be locally confined or semiconfined in the deeper zones. Generally, lateral hydraulic conductivity in most of the Ozark aquifer is considerably higher than vertical hydraulic conductivity. Thus, if all other factors are equal, the rate of horizontal water movement is greater than the rate of vertical water movement. Also, certain formations in the aquifer, or zones in certain formations, have characteristics that are more similar to aquitards than to aquifers. Parts of the Cotter and Jefferson City dolomites and the upper Gasconade Dolomite have much lower vertical and horizontal hydraulic conductivities, than units above and below, and locally can be leaky aquitards. In essence, a thick, heterogeneous aquifer such as the Ozark aquifer consists of relatively permeable horizontal zones separated by less permeable zones.

The variations in hydraulic conductivity within the aquifer are largely responsible for the changes in water level with depth within the aquifer. In regional recharge settings, such as along major surface-water drainage divides, water-level in the aquifer increases with depth, indicating downward water movement. Wells completed in relatively shallow zones may have water levels more than 100 ft higher than wells cased through the shallow zones and completed in deep zones. Where groundwater is discharging from the aquifer the opposite is generally true. This is most often seen along major streams such as the Gasconade, Osage, Current, and North Fork rivers. Here, water

levels in deep wells drilled in valley bottoms generally stand several feet above those of shallow wells, indicating ascending water and discharge from the aquifer into the stream. In many cases, relatively deep wells drilled in this setting will be flowing artesian wells.

There is commonly a perception of mysticism concerning flowing artesian wells. Actually, these wells occur wherever the potentiometric surface of the aquifer that the well penetrates is above land surface. To most people, the term artesian means that water is flowing from a well onto land surface. Strictly speaking, artesian conditions simply mean that the potentiometric surface of an aquifer is above the top of the aquifer. The water level of a well drilled into an artesian aquifer will be above the top of the aquifer, but will not necessarily be above land surface. The groundwater is under some artesian pressure provided by a head differential between the point where recharge to the aquifer occurred and the well. This head difference may be the result of dipping rocks, structural deformation of the rock units, or simply the result of leaky, overlying aquifers providing abundant water to the lower aquifers through permeable vertical connections only a short distance away.

Deep groundwater circulation has been documented numerous times at various places in the Ozarks. For many years, the Division of Geology and Land Survey maintained a groundwater-level monitoring well at West Plains in Howell County. This monitoring well was equipped with a Stevens A-35 water-level recorder that continuously measured and graphically displayed changes in groundwater levels. The recorder was installed on a public water-supply well that was no longer used by the city. This well, drilled in 1914, is 1,305 ft deep and contains 800 ft of pressure-grouted casing. The casing excludes production from the Jefferson City Dolomite, Roubidoux Formation, and most of the Gasconade Dolomite. Producing formations below the casing are the Gunter Sandstone Member, Eminence Dolomite, and upper Potosi Dolomite. Municipal wells for the city of West Plains are cased much deeper than most public water-supply wells in Missouri. The exceptionally deep casing is needed to help prevent shallow recharge from directly entering the wells every time there is measurable precipitation. Despite 800 ft of casing, groundwater levels will rise as much as 200 ft within a few hours after a major rainfall event in the area, and the wells will produce water containing microorganisms that are characteristic of surface water and rapidly recharged groundwater (figure 23).

Ordinarily, there should be no way for recharge to circulate to the deeper zones this quickly, particularly with all of the shallow zones excluded from the well. The type of karst development that occurs in this area is likely the factor controlling the rapid vertical water movement. From a few miles south of Willow Springs, through West Plains, to Thayer, is a band of intense karst development several miles wide. Throughout this area the bedrock has been deeply weathered, leading to the development of thick residuum, many losing streams, and numerous large sinkholes. One of the largest sinkholes in Missouri, Grand Gulf, is near at the southern end of this area near Thayer. Even more interesting is the fact that the karst development is mostly in the Cotter and Jefferson City dolomites that in most other places do not commonly host extensive karst development. The nearly instantaneous water-level changes and rapid introduction of microorganisms are most likely the result of the pressure head increase in the shallow aquifer zones being transmitted to deeper zones because of the high degree of vertical permeability in the aquifer here.

The seasonal fluctuation of groundwater levels throughout southern Missouri directly relates to the recharge and discharge characteristics of the aquifers, and the volume of groundwater produced by area wells. Water levels may rise as much as 15 to 20 ft from late fall to early summer in response to recharge provided by precipitation, and decline through the late summer and fall when recharge is lacking and water use is generally highest. In the fall, after vegetation becomes dormant and temperatures lower, both evaporation

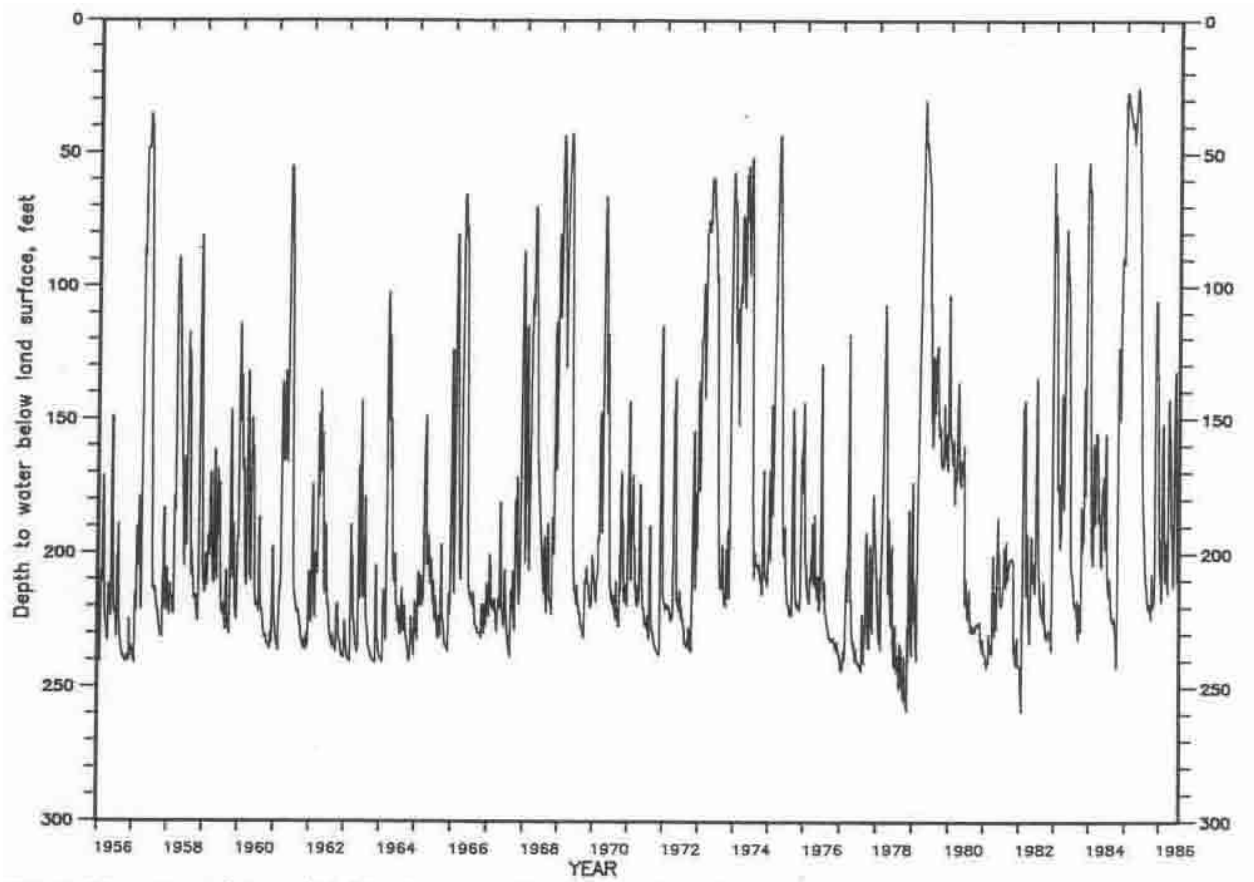


Figure 23. Groundwater-level hydrograph, city of West Plains well #2, Howell County.

and transpiration decrease. With a decrease in these losses, a greater percentage of precipitation becomes groundwater recharge. In the spring, when vegetation begins growing, there is more plant transpiration and temperatures rise, causing more evaporation. Also, the rainfall events during the summer tend to be of shorter duration and more intense, causing more rapid runoff and less infiltration of the water, therefore water levels tend to decline.

The direction that groundwater flows and its rate of flow are controlled by several factors. As with surface water, groundwater will flow from areas of higher head potential to areas of lower head potential. In the shallower, water-bearing zones that have not been appreciably altered by karst development, topography commonly controls the direction of flow; groundwater will flow toward stream valleys or to some point of lower elevation. If the recharge occurs in an upland area, water may flow along the top of a clay pan or fragipan and exit on a hillside as a wet-weather seep. Or, it may move vertically through more permeable residual soil, through smaller unsaturated openings in the shallow bedrock until it reaches the water table, and then move horizontally to a resurgent point at a nearby spring or in a gaining reach of some local stream. Depending on vertical hydraulic conductivity in the formations, part of the recharge may find its way into the deeper, more productive aquifer zones. The rate of flow is dependant on the hydraulic conductivity of the water-bearing material, and the hydraulic gradient. If the hydraulic gradient is essentially flat, then groundwater moves very little even in very permeable materials. Groundwater velocities are greatest in permeable materials where there is an appreciable hydraulic gradient.

The direction of flow in the deeper aquifer zones is controlled primarily by the regional dip or tilt of the formations. As stated in an

earlier section of this report, all of the rocks dip away from the Ozark Dome; deep groundwater movement is controlled by this structure to a large extent, and flow is away from the axis of the dome. Rate of flow in the deeper horizons is much slower than in the shallower zones, but is still controlled by the amount of dip of the rock.

The Effects of Karst Development on Groundwater Movement

The most significant geologic condition that influences groundwater recharge and movement in the Salem Plateau is the presence of karst features. Karst is a term used to describe an area where the dissolving of soluble bedrock has led to the formation of a variety of features such as caves or other underground drainage conduits, sinkholes, solutionally enlarged crevices, losing streams, springs, and other less common features. Karst features can generally be categorized into groundwater recharge, groundwater transport, and groundwater discharge features.

Sinkholes

Sinkholes and losing streams are the two most common karst groundwater-recharge features in the Salem Plateau. Sinkholes, which are topographic depressions formed by the dissolution and subsurface removal of the earth materials, are common in many areas of the Salem Plateau, predominately in upland settings. In some areas of the Salem Plateau, particularly between West Plains and Thayer, and in the counties of Perry and Ste. Genevieve, sinkholes drain areas of several square miles or more. The sinkhole drainage areas in eastern Perry and Ste. Genevieve counties generally consist of hundreds of sinkholes developed within larger sinkhole plains. Within the boundaries of these sinkhole plains essentially all of the runoff is funneled into the subsurface; there is no surface-water outflow. Between West Plains and Thayer in southeastern Howell and southwestern Oregon counties, there are numerous large sinkholes. Some of these sinkhole basins are large enough to topographically resemble surface drainages; however, the drainages end in large depressions where the water must enter the subsurface. The largest of these is Grand Gulf, the focal point of Grand Gulf State Park about five miles west of Thayer in Oregon County (figure 24). Grand Gulf is a collapsed cave that forms a sinkhole more than one mile long. The collapse captured the flow of Bussell Branch, a surface watershed containing nearly 20 square miles of drainage. Bussell Branch is a losing stream, and only provides inflow into Grand Gulf after heavy rainfall. However, the uncollapsed part of the cave, which continues at the downstream end of Grand Gulf, is sufficiently choked with mud and organic debris so that after heavy rainfall the sinkhole will flood to the depths of more than 100 ft for periods of several weeks. Water entering Grand Gulf reappears within a few days at Mammoth Spring, Arkansas' largest spring, about eight miles to the southeast (Vineyard and Feder, 1982).

Losing Streams

Losing-stream segments are common throughout the Salem Plateau. It is not uncommon to see a well-developed stream valley and channel that transports surface flow only after major rainfall events. In most instances, there is no surface flow in losing-stream watersheds until the alluvial materials become saturated and the solution-enlarged bedrock openings that channel water into the subsurface can no longer channel all of the flow underground. Surface flow is generally sustained for periods of a few hours to a few days, until it recedes to where the bedrock openings can again accept all of the water and channel it into the subsurface. Some streams contain both losing and gaining reaches. Flow may be lost into the subsurface in a losing segment, while groundwater from seeps of springs may provide flow in another gaining reach. In some places the flow that is lost into the subsurface in an upstream losing reach reappears at a spring in the downstream gaining reach of the same valley, but it is not uncommon for flow to be diverted through the subsurface to a different drainage.

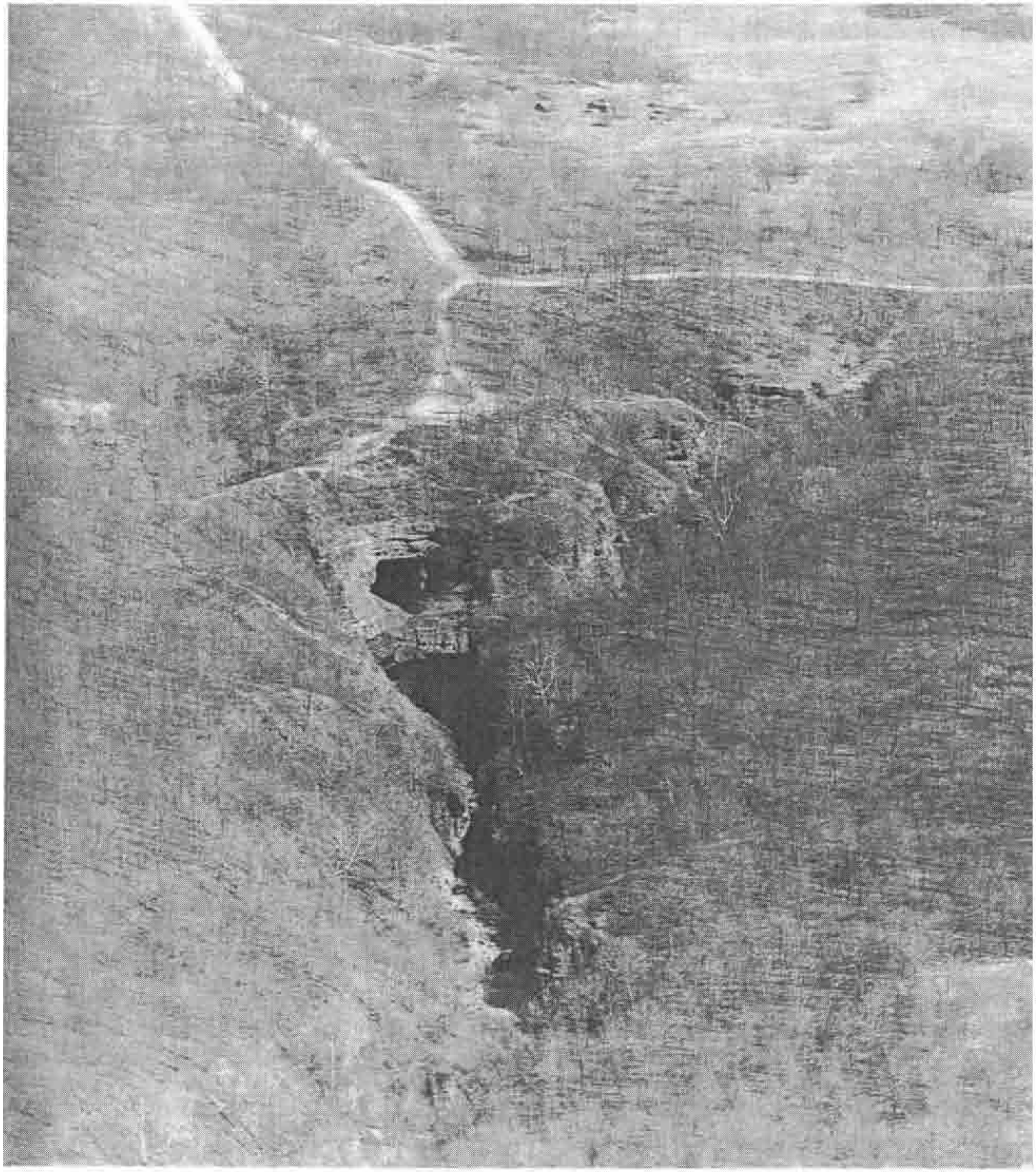


Figure 24. Grand Gulf, an immense sinkhole and collapsed cave system near Thayer in Oregon County. Photo by Jerry D. Vineyard.

Losing streams are found throughout the Salem Plateau and account for much of the rapid groundwater recharge that feeds the large spring systems. Figure 25 shows the locations of major losing-stream watersheds in the Salem Plateau. Losing streams can be found in every county and river basin in the Salem Plateau, but are especially common in Shannon, Carter, Howell, Oregon, Texas, Phelps, Pulaski and Laclede counties. Indi-

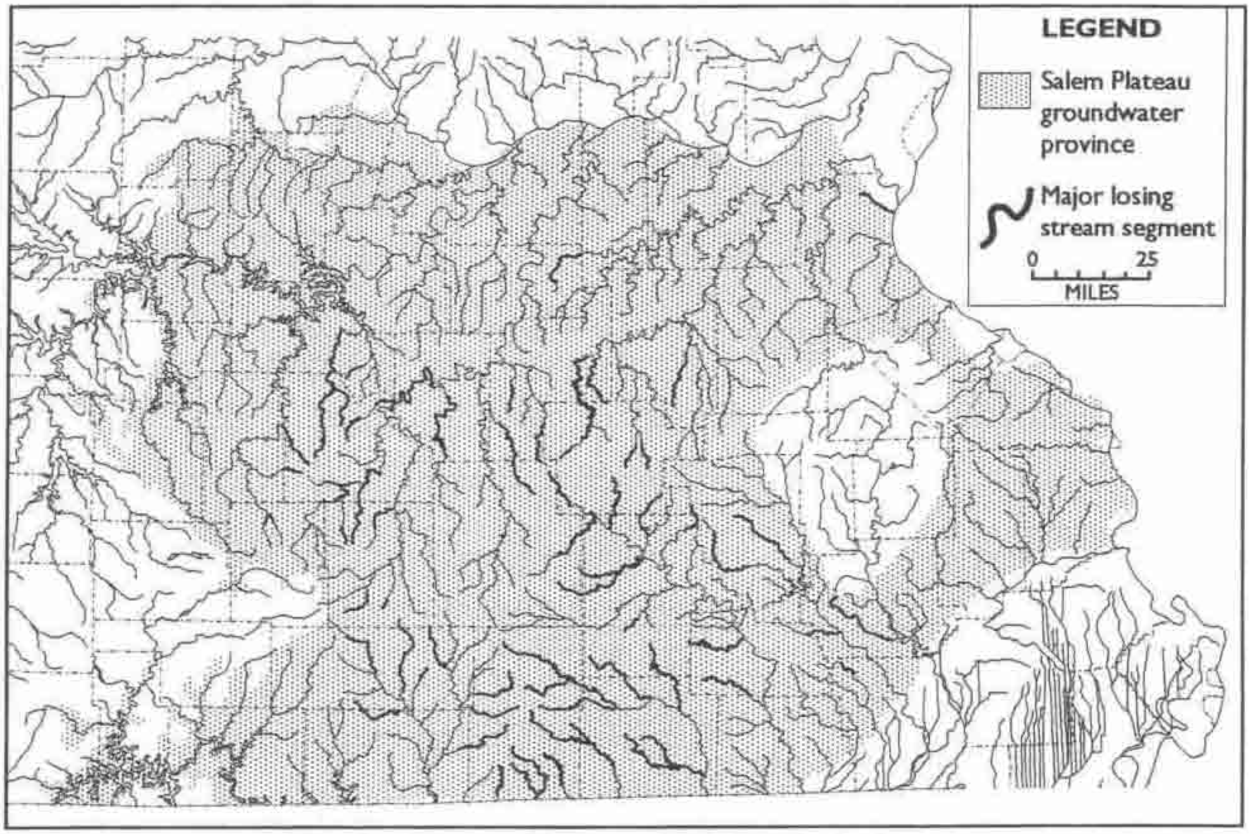


Figure 25. Major losing streams in the Salem Plateau groundwater province.

vidual losing-stream watersheds may contain more than 100 square miles of drainage where nearly all of the runoff is channeled underground rather than leaving the watershed by surface flow. In most cases, the water table in losing-stream valleys is well below streambed elevation. The presence of conduits in the subsurface that transport water to the receiving spring dewaters the adjacent part of the aquifer and lowers the potentiometric surface in the vicinity of the conduits.

Caves and Karst Conduits

The Salem Plateau contains about 3,600 of Missouri's more than 5,500 known caves. Most of the caves that can be entered today in the Salem Plateau are former paths of groundwater movement that no longer transport significant volumes of groundwater. However, in some areas, particularly where sinkholes provide most of the surface drainage, enterable caves are still active groundwater conduits. This is especially true in parts of the eastern Salem Plateau such as Perry County. Many of the longest caves in Missouri are in Perry County, and all are active groundwater conduits that transport water from large sinkhole areas to springs and karst resurgences along area streams. Crevice, Mystery, Rimstone River caves, and the Moore Cave System in Perry County, are some of Missouri's longest caverns. Their combined mapped lengths total more than 60 miles. All of them are entered through sinkholes, drain large sinkhole plains, and discharge their waters into local gaining-stream drainages that bisect the sinkhole plains.

The springs, which are the outfalls of these cave systems, normally have small discharges. However, after heavy rainfall, these springs may discharge more than 100 ft^3/sec. Normally dry karst resurgences are associated with most of these caves and springs. These karst resurgences discharge no flow except

during very wet weather when they will function briefly as overflow outlets for the karst drainage system. Any of the carbonate units in the Ozarks can host caves, but the majority of the caves are developed in the Roubidoux Formation, Gasconade Dolomite, and Eminence Dolomite. In the Perry County area, the Joachim Dolomite and Plattin Limestone host many caves. The longest air-filled caves in Missouri are in Perry County and Crevice Cave, the longest, contains more than 27 miles of mapped passage.

In many types of aquifers, groundwater moves only a few feet to a few hundred feet per year. In karst areas, groundwater velocities may be several orders of magnitude greater. Groundwater velocities in karst systems in the Salem Plateau have been measured using water tracing methods. Water tracing is a technique used to establish a physical link between where water disappears into the subsurface, such as in a sinkhole or a losing stream, to where it resurfaces at a spring or in a gaining stream segment. Water-soluble fluorescent dyes are normally used as tracing agents. Ordinarily, water tracing will not delineate the actual path that the groundwater followed. It does, however, demonstrate the physical connection between recharge and discharge points. Straight-line velocities measured using dye tracing are locally more than two miles per day. Average velocities are somewhat lower. In the central and northern parts of the province, straight-line velocities measured using tracer dyes average about 0.5 miles per day, while to the south, particularly in the Current River and Eleven Point River basins, average straight-line velocity appears

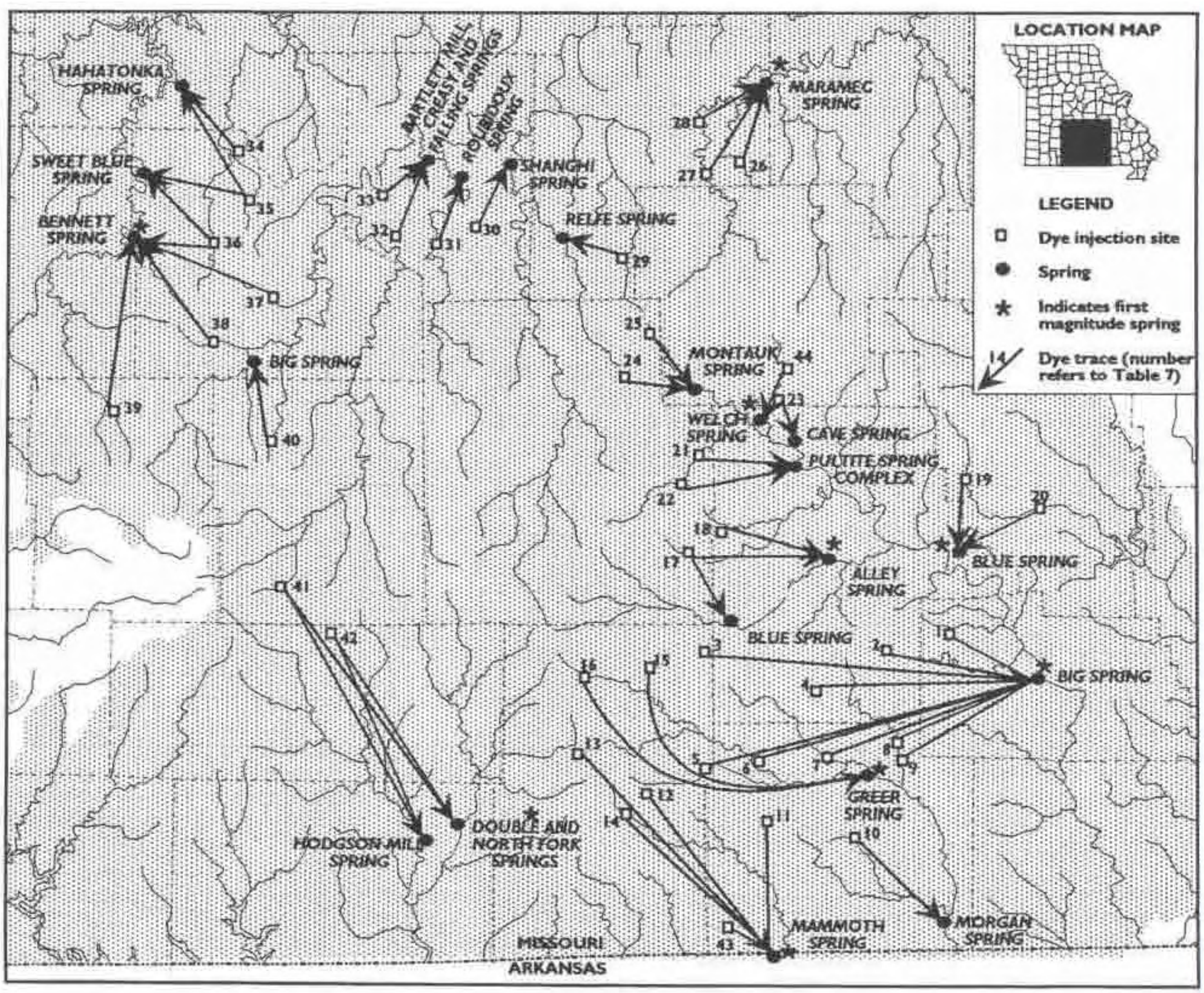


Figure 26. Selected major groundwater traces in the Salem Plateau groundwater province.

Ref. No.	Injection Data				Recovery Data				Trace Length (miles)	Data Source ***
	County	Location Sec./Twn./Rng.	Injection Date	Agent & Amount (lbs)**	Spring Name	County	Location Sec./Twn./Rng.	First Recovery Interval		
1*	Carter	4 27N 2W	8-1-84	Fl, 6	Big	Carter	6 26N 1E	8-12-95 to 8-22-95	12.4	Aley & Aley (1987)
1*	Carter	4 27N 2W	8-1-84	Fl, 6	Mill Creek	Carter	6 27N 1W	8-6-95 to 8-13-95	4.5	Aley & Aley (1987)
2	Shannon	18 27N 3W	5-10-73	Fl, 10	Big	Carter	6 26N 1E	5-16-73 to 5-22-73	19.2	Aley (1975)
3	Howell	24 27N 7W	4-17-72	Fl, 15	Big	Carter	6 26N 1E	4-25-72 to 5-2-72	38.1	Aley (1975)
4	Shannon	12 26N 5W	12-10-71	Fl, 10	Big	Carter	6 26N 1E	12-13-71 to 12-20-71	25.3	Aley (1975)
5	Howell	26 25N 7W	1-18-72	Fl, 10	Big	Carter	6 26N 1E	1-31-72 to 2-4-72	39.5	Aley (1975)
6	Oregon	14 26N 6W	8-26-71	Fl, 7	Big	Carter	6 26N 1E	10-22-71 to 11-9-71	33.5	Aley (1975)
7	Oregon	13 25N 5W	12-17-74	Fl, 8	Big	Carter	6 26N 1E	12-18-74 to 2-20-75	26.4	Aley (1975)
8	Oregon	9 25N 3W	11-18-70	Fl, 10	Big	Carter	6 26N 1E	11-24-70 to 12-1-70	17.5	Aley (1975)
9	Oregon	22 25N 3W	8-29-69	Fl, 5	Big	Carter	6 26N 1E	9-8-69 to 9-15-69	18.0	Aley (1975)
10	Oregon	28 24N 4W	5-28-69	Fl, 10	Morgan	Oregon	16 22N 2W	8-11-69 to 8-25-69	15.5	Aley (1975)
11	Oregon	29 24N 5W	12-16-70	Fl, 10	Mammoth	Fulton, AR	5 21N 5W	12-30-70 to 1-12-71	14.5	Aley (1975)
12	Howell	10 24N 8W	6-14-72	Fl, 10	Mammoth	Fulton, AR	5 21N 5W	6-22-72 to 7-5-72	25.0	Aley (1975)
13	Howell	20 25N 9W	8-14-72	Fl, 10	Mammoth	Fulton, AR	5 21N 5W	8-28-72 to 9-8-72	32.8	Aley (1975)
14	Howell	26 24N 8W	5-18-78	Fl, 10	Mammoth	Fulton, AR	5 21N 5W	5-26-78 to 5-30-78	23.4	Dean DGLS-DTDB
15	Howell	35 27N 8W	11-9-72	Fl, 15	Greer	Oregon	36 25N 4W	11-15-72 to 11-27-72	27.5	Aley (1975)
16	Howell	33 27N 9W	9-9-75	Fl, 15	Greer	Oregon	36 25N 4W	9-11-75 to 9-22-75	34.5	Tryon DGLS-DTDB
17*	Texas	22 29N 7W	4-4-78	Fl, 8	Alley	Shannon	25 29N 5W	4-5-78 to 4-19-78	14.4	Aley & Aley (1987)
17*	Texas	22 29N 7W	4-4-78	Fl, 8	Blue	Shannon	31 28N 6W	4-4-78 to 4-19-78	9.0	Aley & Aley (1987)
18	Shannon	8 29N 6W	11-1-72	Fl, 10	Alley	Shannon	25 29N 5W	11-1-72 to 11-9-72	11.0	Aley (1975)
19	Reynolds	14 30N 2W	10-7-69	Rwt, 5	Blue	Shannon	21 29N 2W	10-10-69 to 10-20-69	9.5	Feder & Barks (1972)
20	Reynolds	3 29N 1W	4-14-82	Fl, 8	Blue	Shannon	21 29N 2W	4-14-82 to 4-28-82	8.3	Aley & Aley (1982)
21*	Texas	34 31N 7W	4-2-86	Fl, 5	Pulltite Complex	Shannon	33 31N 5W	4-2-86 to 4-16-86	11.0	Aley & Aley (1987)
22*	Texas	7 30N 7W	6-16-78	Fl, 8	Pulltite Complex	Shannon	33 31N 5W	6-27-78 to 7-18-78	13.1	Aley (1978)
23	Dent	31 32N 5W	5-12-82	Fl, 8	Cave	Shannon	21 31N 5W	5-12-82 to 5-26-82	5.0	Aley & Aley(1982)
24	Texas	17 32N 8W	9-30-86	Rwt, 12	Montauk	Dent	22 32N 7W	10-13-86 to 10-21-86	8.0	Vandike/Gooding/Endicott DGLS-DTDB
25	Texas	36 33N 8W	4-8-87	Rwt, 12	Montauk	Dent	22 32N 7W	4-8-87 to 4-22-87	6.4	Vandike/Endicott DGLS-DTDB
26	Phelps	21 36N 6W	8-3-94	Fl, 6	Maramec	Phelps	1 37N 6W	8-15-97 to 8-24-94	9.6	Vandike (1996)
27	Phelps	35 36N 7W	5-13-82	Rwt, 27	Maramec	Phelps	1 37N 6W	5-25-82 to 5-26-82	12.8	Vandike (1985)
28	Phelps	26 37N 7W	3-26-94	Rwt, 9	Maramec	Phelps	1 37N 6W	4-1-94 to 4-7-94	7.8	Vandike (1996)
29	Phelps	8 34N 8W	10-4-94	Fl, 5	Relfe	Phelps	36 35N 10W	10-4-94 to 12-6-94	8.5	Vandike (1996)
30	Pulaski	32 35N 11W	6-9-71	Fl, 8	Shanghai	Pulaski	24 36N 11W	7-2-71 to 7-9-71	8.4	Tryon DGLS-DTDB
31	Pulaski	3 34N 12W	10-1-70	Fl, N/A	Roubidoux	Pulaski	25 36N 12W	N/A	10.5	DeanDGLS-DTDB
32*	Pulaski	36 35N 13W	5-5-88	Rwt, 12	Bartlett Mill	Pulaski	16 36N 12W	5-16-88 to 6-9-88	9.2	Vaughn DGLS-DTDB
32*	Pulaski	36 35N 13W	5-5-88	Rwt, 12	Creasy	Pulaski	16 36N 12W	5-15-88 to 6-4-88	9.2	Vaughn DGLS-DTDB
32*	Pulaski	36 35N 13W	5-5-88	Rwt, 12	Falling	Pulaski	17 36N 12W	5-15-88 to 6-4-88	9.0	Vaughn DGLS-DTDB

Table 7. Major groundwater traces in the Salem Plateau groundwater province.

Table 7 continued

Ref. No.	Injection Data				Recovery Data				Trace Length (miles)	Data Source ***
	County	**Location Sec./Twn./Rng.**	**Injection Date**	**Agent & Amount (lbs)****	**Spring Name**	**County**	**Location Sec./Twn./Rng.**	**First Recovery Interval**		
32*	Pulaski	36 35N 13W	5-5-88	Rwt, 12	Sowers	Pulaski	16 36N 12W	5-15-88 to 6-4-88	9.2	Vaughn DGLS-DTDB
33*	Pulaski	10 35N 13W	3-19-92	Rwt, 9	Bartlett Mill	Pulaski	16 36N 12W	3-26-92 to 4-2-92	7.1	Vandike DGLS-DTDB
33*	Pulaski	10 35N 13W	3-19-92	Rwt, 9	Creasy	Pulaski	16 36N 12W	3-26-92 to 4-2-92	6.6	Vandike DGLS-DTDB
33*	Pulaski	10 35N 13W	3-19-92	Rwt, 9	Falling	Pulaski	17 36N 12W	3-26-92 to 4-2-92	6.5	Vandike DGLS-DTDB
34	Laclede	24 36N 16W	4-18-80	Rwt, 35	Hahatonka	Camden	2 37N 17W	4-25-80 to 5-2-80	11.0	Miller/Vandike DGLS-DTDB
35*	Laclede	30 35N 15W	11-3-76	Rwt,, N/A	Sweet Blue	Laclede	30 36N 17W	11-26-76 to 12-5-76	13.4	Miller/Skelton DGLS-DTDB
35*	Laclede	30 35N 15W	11-3-76	Rwt, N/A	Hahatonka	Camden	2 37N 17W	12-18-76 to 12-26-76	17.6	Miller/Skelton DGLS DTDB
36*	Laclede	4 34N 16W	4-19-90	Fl, 6	Bennett	Dallas	1 34N 18W	5-3-90 to 5-14-90	9.1	Vandike 1992
36*	Laclede	4 34N 16W	4-19-90	Fl, 6	Sweet Blue	Laclede	30 36N 17W	5-3-90 to 5-14-90	11.7	Vandike (1992)
37	Laclede	28 34N 15W	2-27-90	Rwt, 12	Bennett	Dallas	1 34N 18W	3-22-90 to 3-27-90	16.2	Vandike (1992)
38	Laclede	28 33N 16W	7-26-90	Fl, 5	Bennett	Dallas	1 34N 18W	8-6-90 to 8-7-90	14.7	Vandike (1992)
39	Webster	3 31N 18W	11-21-89	Rwt, 12	Bennett	Dallas	1 34N 18W	12-5-89 to 12-18-89	19.3	Vandike (1992)
40	Wright	28 31N 15W	1-11-90	Fl, 15	Big	Laclede	6 32N 15W	1-11-90 to 2-21-90	10.3	Vandike (1992)
41*	Wright	11 28N 15W	4-18-86	Fl, 10	Double	Ozark	32 24N 11W	4-18-86 to 5-2-86	34.8	Williams DGLS-DTDB
41*	Wright	11 28N 15W	4-18-86	Fl, 10	North Fork	Ozark	28 24N 11W	4-18-86 to 5-2-86	34.5	Williams DGLS-DTDB
41*	Wright	11 28N 15W	4-18-86	Fl, 10	Hodgson Mill	Ozark	34 24N 12W	4-18-86 to 5-2-86	33.2	Williams DGLS-DTDB
42*	Douglas	3 27N 14W	11-2-88	Rwt, 12	Double	Ozark	32 24N 11W	11-10-88 to 11-17-88	27.7	Pendleton/Brown DGLS-DTDB
42*	Dougas	3 27N 14W	11-2-88	Rwt, 12	North Fork	Ozark	28 24N 11W	11-10-88 to 11-17-88	27.5	Pendleton/Brown DGLS-DTDB
42*	Douglas	3 27N 14W	11-2-88	Rwt, 12	Hodgson Mill	Ozark	34 24N 12W	11-10-88 to 11-17-88	26.4	Pendleton/Brown DGLS-DTDB
43	Oregon	20 22N 6W	10-16-67	Fl, 0.5	Mammoth	Fulton, AR	5 21N 5W	10-16-67 to 10-17-67	7.0	Aid DGLS-DTDB
44	Dent	8 32N 5W	12-4-85	Fl, 6	Welch		10 31N 6W	12-7-85 to 12-22-85	7.1	Aley & Aley (1987)

* Dye recovered at multiple springs

** Fl - Fluoroscein or Uramine C; Rwt - Rhodamine WT

*** DGLS-DTDB - Division of Geology and Land Survey Dye Trace Database

to be closer to 1 mile per day. Velocities are generally highest following heavy precipitation and lowest during extended periods of dry weather. Dye traces greater than 35 miles in length have been conducted in the Salem Plateau in some of the larger spring systems. Figure 26 is a map of the Salem Plateau groundwater province showing the injection points and resurgence points for major water or dye-tracing studies. Table 7 lists physical data for these dye traces.

Springs

Springs are the primary outlet points for groundwater moving through karst groundwater systems, and the Salem Plateau is host to thousands of springs. There are more than 2,900 springs recorded in Missouri, with an estimated 1,500 of these in the Salem Plateau. There very likely exists a great number of smaller springs for which no information has been gathered.

Springs in the Salem Plateau range from spectacular groundwater outlets such as Big Spring and Greer Spring, with flows averaging several hundred million gallons a day, to very small springs with discharges of only a few gallons a minute. Springs are commonly classified by their size. One technique for classifying springs is by the magnitude of their discharge. Meinzer (1927) devised a spring discharge classification system that is still widely used. The system, shown in table 8, divides springs into five magnitudes. The larger the spring, the smaller the magnitude number.

MAGNITUDE	DISCHARGE
First	100 ft^3/sec or greater
Second	10 to 100 ft^3/sec
Third	1 to 10 ft^3/sec
Fourth	100 gpm to 1 ft^3/sec (448.8 gpm)
Fifth	10 to 100 gpm

Table 8. Meinzers (1927) classification system for springs.

Under Meinzer's classification, a first magnitude spring has an average flow in excess of 100 ft^3/sec or 64.6 million gallons a day. Missouri has eight known first magnitude springs. All of them are in the Salem Plateau groundwater province, and all of them discharge from deep water-filled cave openings developed in the lower Gasconade and Eminence dolomites. The largest is located in Carter County south of Van Buren near the Current River, and is appropriately named "Big Spring." There are easily a dozen springs in Missouri named Big Spring, and local standards obviously apply when giving springs their name. The smallest "Big Spring" is but a trickle when compared to Big Spring in Carter County, which has an average discharge of 446 ft^3/sec, or 288 million gallons per day, and is one of the worlds largest single-outlet springs (Vineyard and Feder, 1982). Twenty three miles southwest of Big Spring near the Eleven Point River in Oregon County is Missouri's second largest spring, Greer Spring. Greer Spring discharges from two outlets spaced a few hundred feet apart in the base of a steep valley. It has an average discharge of 388 ft^3/sec (251 million gallons per day). Table 9 shows the names and locations of Missouri's eight largest springs.

Springs show tremendous variation in appearance, discharge, flow characteristics, and water quality. However, all springs have one common characteristic—each has an area from which it receives recharge. Most commonly, a spring's recharge area supplies water to only that spring, but there are many cases where two or more springs share a common recharge area. The size of area needed for recharging a spring depends on the recharge rate and the discharge of the spring. The source of the recharge is ultimately precipitation. However, only a part of the total precipitation is available for groundwater recharge; most of the water is lost back to the atmosphere through evaporation or transpired by plants. These two losses account for about two thirds of the available water. Of the remaining one-third, some may be lost from the recharge area by surface flow. Realistically, a maximum of about 12 inches of water per year is available for groundwater recharge in most areas of the Salem Plateau, in many cases the amount may be substantially less.

	LOCATION				DISCHARGE (ft^3/sec)			
Spring	**County**	**Sec.**	**Twn.**	**Rng.**	**min.**	**max.**	**avg.**	**number of measurements**
Big	Carter	6	26N	1E	236	2000*	447	Continuous, 1921-96
Greer	Oregon	36	25N	4W	104	1010	344	Continuous, 1921-96
Welsh	Shannon	14	31N	6W	70	492	186	38 measurements—1923-94
Bennett	Dallas	1	34N	18W	55	6350**	177	Continuous, 1916-20, 1928-41, 1965-93
Maramec	Phelps	1	37N	6W	56	1100	155	Continuous, 1903-05, 1922-29, 1965-85
Alley	Shannon	25	29N	5W	54	2750	135	Continuous, 1928-39, 1965-79
Blue	Shannon	21	29N	2W	62	301	131	47 measurements—1923-94
Double	Ozark	32	24N	11W	47	232	127	27 measurements—1919-66

* = estimated
** = flow includes runoff from Spring Hollow

Table 9. Names, locations and discharge characteristics of first magnitude springs in Missouri.

In general, the larger a spring's discharge, the larger the recharge area. A spring discharging an average flow of 10 gpm most likely has a recharge area that is relatively small, and close to the spring. Assuming an average recharge rate of 12 inches per year, a spring with a discharge averaging 10 gpm would need a recharge area of only about 16 acres. A spring with an average flow of 100 ft^3/sec would require a much larger recharge area, 113 square miles, assuming a recharge rate of 12 inches per year. Thus, assuming a recharge rate of 12 inches per year, Big Spring would require a recharge area of about 505 square miles. Obviously, if two springs have similar recharge rates, the spring having the lower average discharge would require proportionally less recharge area. The recharge area size of a spring can be calculated from spring discharge and recharge rates using the following equation:

$$RA = 13.584 \times Q_{avg} / R$$

where: RA = recharge area (mi^2)
Q_{avg} = average discharge (ft^3/sec)
R = average annual recharge (inches)

The recharge areas for many springs in the Salem Plateau have been at least partly delineated using water tracing techniques. However, even where extensive water tracing studies have been conducted, it is not possible to delineate a spring recharge area with total accuracy. It is simply not feasible to conduct dye traces from all possible recharge sources. Despite this, much is known about the recharge areas and flow characteristics of many springs in the Salem Plateau. Though it is beyond the scope of this report to present detailed discussions of numerous springs, some examples of the springs and their flow characteristics are necessary to show the complexity of these karst drainage systems.

Aside from being the largest single-outlet spring in Missouri, Big Spring has some very interesting hydrologic characteristics. Big Spring discharges from the Eminence Dolomite at the base of a steep bluff only a few hundred feet from the banks of the Current River a few miles south of Van Buren in Carter County. Although the spring is within the Current River basin, most of its recharge originates from outside of the Current River basin. Numerous dye traces by Aley (1975, 1987), Duley (1982) and others show that Big Spring receives more recharge from water lost into the subsurface within the Eleven Point River basin than from within the Current River basin. The upper Eleven Point River contains numerous losing-stream reaches, and most of its northern tributaries are also losing-stream watersheds. Much of this water is pirated from the Eleven Point River basin and channeled through the subsurface into the Current River basin to recharge Big Spring.

The interbasin transfer of groundwater from the Eleven Point River into the Current River through Big Spring results in an increase in average annual runoff for the Current River and a decrease in runoff for the Eleven Point River. This can easily be seen by comparing runoff rates for the two rivers. The Current River basin upstream from Van Buren, which is about three miles upstream from Big Spring, has an average annual runoff rate of 16.23 inches. In other words, the volume of water flowing by Van Buren during an average year would cover the entire Current River basin upstream of it to a depth of 16.23 inches. The addition of water from Big Spring and other smaller springs downstream of Van Buren raises the average annual runoff rate to 18.70 inches, which is observed at the USGS gaging station at Doniphan, a few miles downstream from Big Spring. The long-term average runoff rate for the Eleven Point River upstream of the U.S. 160 bridge near Bardley is more than 5 inches lower at 13.45 inches. The difference between the two is mostly the water that is pirated from the Eleven Point and channeled into the Current.

Big Spring, like nearly all major springs in the Salem Plateau, responds quickly to precipitation in the recharge area. The recharge changes more than just the discharge of Big Spring—it also raises the water level in the aquifer. The Division of Geology and Land Survey has maintained a groundwater-level observation well about one-half mile west of Big Spring since 1971. The water level in the well, which is 56 ft deep and produces from the Eminence Dolomite, fluctuates with precipitation in much the same way as Big Spring discharges (figure 27). So close is the relationship between water level in the observation well and the discharge of Big Spring that the spring's discharge can be closely estimated from water level in the well.

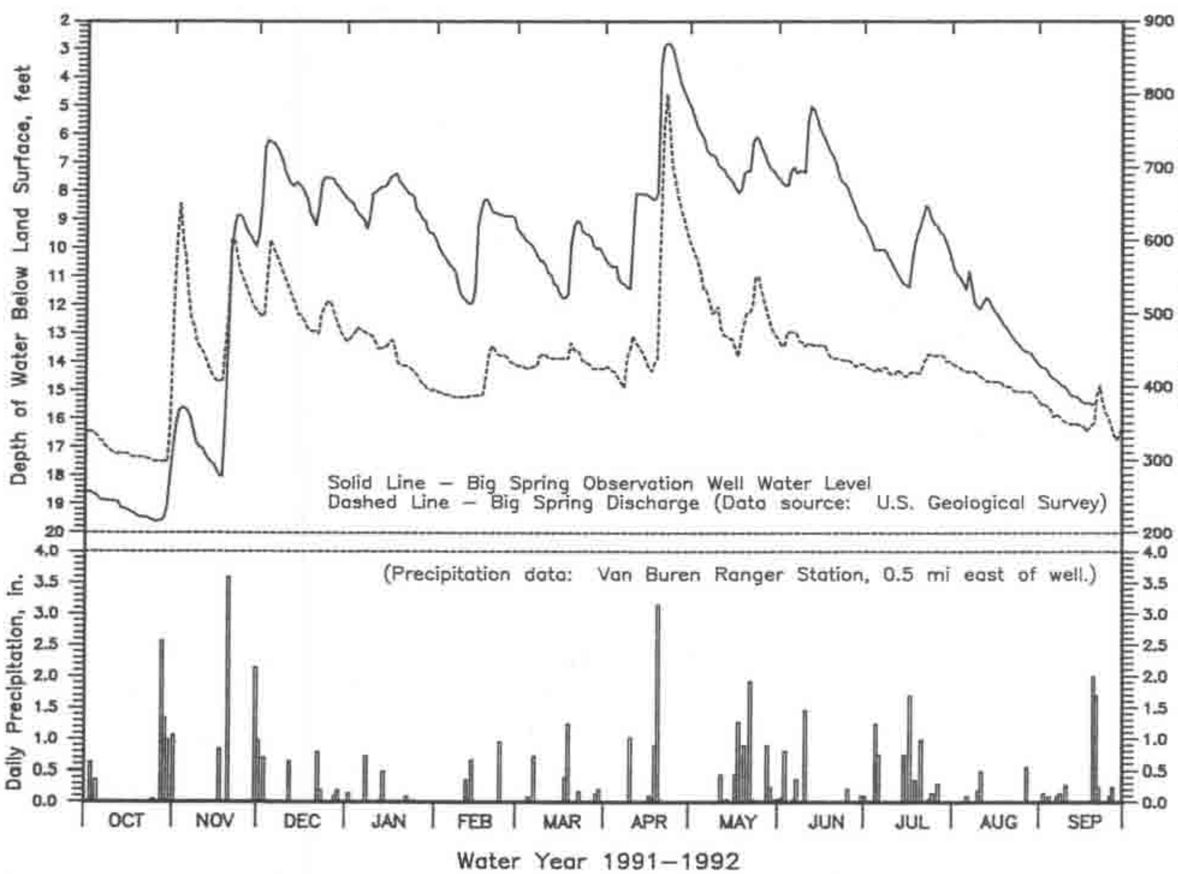


Figure 27. Groundwater-level hydrograph of Big Spring observation well, discharge of Big Spring, and local precipitation.

Big Spring is not the only spring in the Current River basin that receives recharge from outside of the basin boundaries. Blue Spring in Shannon County near Owls Bend has an average discharge of about 131 ft^3/sec and is Missouri's seventh largest spring. Water tracing by Feder and Barks (1972) and Aley and Aley (1982) show that much of the water that discharges from Blue Spring originates within the Black River basin. Logan Creek, a large Black River tributary, contains gaining-stream reaches at either end of the watershed, but has a losing reach several miles long through the middle of the watershed. Upstream of the losing reach, Logan Creek drains an area of about 82 square miles. Dye introduced into Logan Creek where flow ends at the upper end of the losing reach reappears at Blue Spring nearly nine miles to the southwest.

Blue Spring has the distinction of being Missouri's deepest known spring. Like nearly all of the first magnitude springs, the submerged cave that channels water to the mouth of Blue Spring is steeply inclined for the first few hundred feet and then assumes a more horizontal nature. Divers working in Blue Spring report reaching depths of nearly 300 ft before the water-filled cave becomes nearly horizontal. Most of the other first magnitude springs that have been explored by divers are about 100 to 140 ft deep.

Many Missouri spring systems are quite complex. The simplest case is a single spring that is recharged from a particular area that supplies water to only that spring. More complex systems have several springs that share parts or all of their recharge area. Double Spring in Ozark County is the largest spring in the North Fork River basin and, with an average discharge of about 127 ft^3/sec, is about the eighth largest in Missouri. A short distance upstream from Double Spring, North Fork Spring rises from the bed and banks of the North Fork River and adds an average of about 70 ft^3/sec into the river. The hydrologic connection between these two springs was determined by dye tracing in the 1970s, but additional study several years later showed that Double and North Fork springs are also hydrologically connected with Hodgson Mill Spring, which is about 5 miles west of them in the Bryant Creek basin. Williams (1987) conducted several water traces from the headwaters of the Gasconade River basin near Mansfield. Dye from all of these traces was recovered at Double, North Fork and Hodgson Mill springs. Water samples collected periodically from all three springs during a several year period shows that the water discharging from them is essentially identical, even it its chemistry. This strongly indicates that the springs are separate outlets for a single karst drainage system, and share a common recharge area.

One of the most interesting characteristics of springs is how they respond to precipitation. The discharge rate of many springs rises dramatically shortly after a rainfall event. The discharge decreases nearly as rapidly for a short time after the discharge peaks, but then the recession curve flattens as the discharge approaches the pre-storm discharge value (figure 28). This is explained when one considers that a spring is nothing more than the discharge point for a complicated three-dimensional underground drainage system. Intersecting fractures within the recharge area for the spring transport water through progressively larger cracks and crevices toward the spring.

Maramec Spring, near St. James in Phelps County, is Missouri's 5th largest with an average discharge of about 155 ft^3/sec. It receives recharge from several losing-stream watersheds in the upper Meramec River basin including Dry Fork, Norman Creek, Asher Hollow, and several of their tributaries. Several detailed studies of Maramec Spring allowed the collection of extensive discharge, precipitation, and water quality information. In one study, water samples were collected from the spring at 4-hour intervals for a one-year period (Driess, 1989).

In another study, a specific conductance probe and data logger were installed in the spring branch that collected hourly specific conductivity values for more than a year. Specific conductivity is a measure of the electrical conductance of water. The conductivity

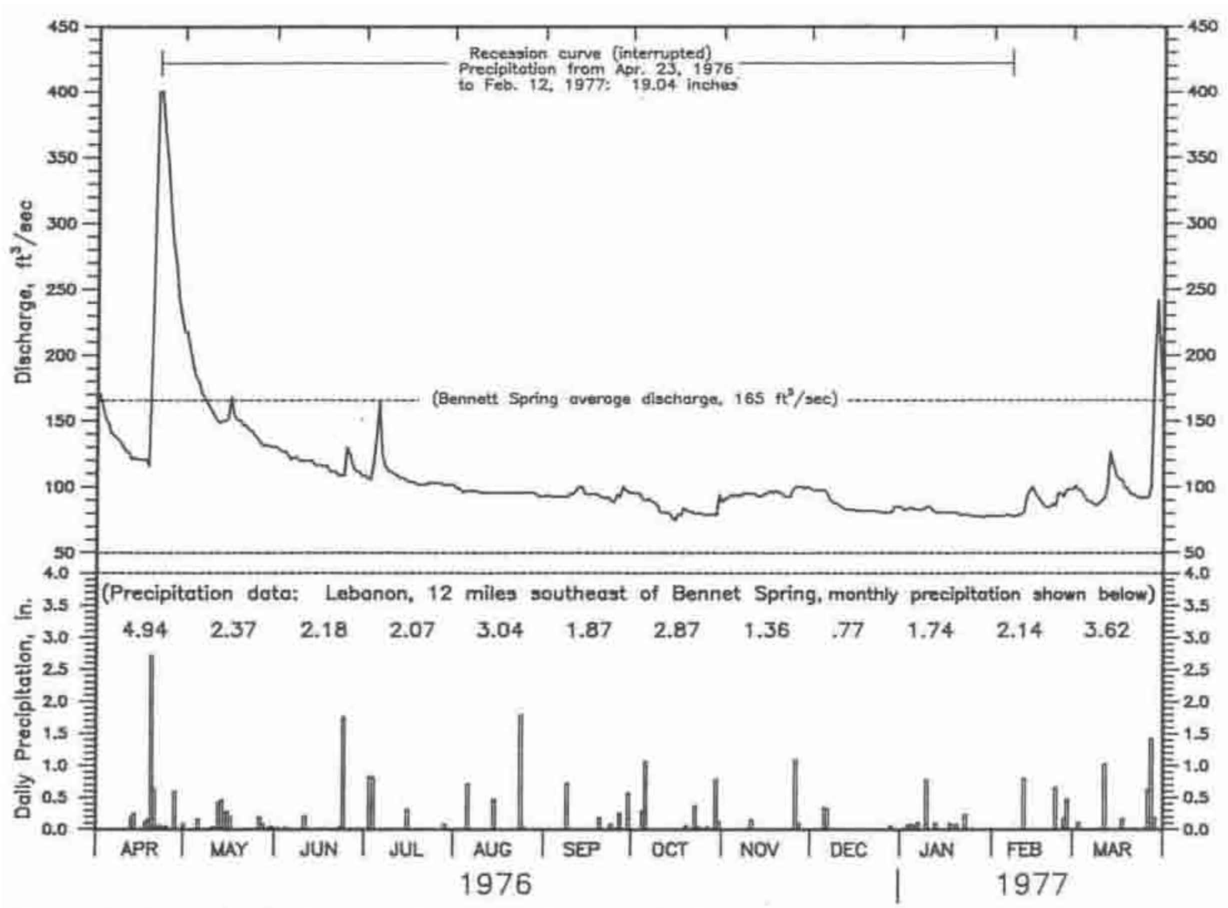


Figure 28. Recession hydrograph, Bennett Spring, Laclede County.

of water is directly proportional to the quantity of dissolved minerals. Precipitation, before reaching the ground, contains very little dissolved minerals and thus has a very low conductivity. Once in contact with the earth materials, the water begins dissolving rock and increasing its dissolved solids load. In a spring system, recent recharge generally has a significantly lower conductivity than water which has been in the spring system and in contact with the rock for a longer period. There are several National Weather Service precipitation stations in the area, some of which collect hourly rainfall data. Additional precipitation stations were established in the recharge area during both studies to allow hourly rainfall amounts to be measured and recorded.

Discharge data is collected at Maramec Spring through a digital water-level recorder that takes hourly spring-stage readings. The stage values are converted to discharge values through a stage-discharge rating table developed for the spring.

The detailed water quality, discharge and precipitation data collected from Maramec Spring and its recharge area shows that discharge begins increasing at the spring within a few hours of when rainfall begins. Discharge peaks soon after rainfall ceases, and then begins decreasing. Water from the rainfall event however, does not reach Maramec Spring for several days. The increase in discharge is due to an increase in head pressure in the recharge area from the influx of recharge. The recharge causes the water level in the aquifer to rise, which forces the water already in the conduit system to increase in velocity. The process is much the same as having a long garden hose attached to a faucet

that is partially opened. If the faucet is then fully opened, flow begins increasing immediately at the end of the hose, but the water that caused the flow to increase does not reach the nozzle for some time. At Maramec Spring, most of the recharge from a precipitation event reaches the spring several days after the discharge peak occurs. As the fresh recharge begins exiting from the spring, the dissolved solids load of the water begins decreasing, as does the specific conductance. This is because the water has not been in contact with the earth materials long enough to have an appreciable amount of materials. As the fresh recharge drains through the system, it will slowly increase its dissolved solids content, and a few weeks after the rainfall event the chemistry of the water approximates the pre-storm conditions (figure 29).

During dry weather, discharge at Maramec Spring slowly decreases as water-level in the aquifer in the recharge area declines. During very dry weather, nearly all of the spring discharge is derived from aquifer storage. This is water that has been in contact with the rock for a longer period of time, and subsequently the dissolved solids content of the water is relatively high (Vandike, 1996).

The discharge characteristics of springs also give important clues to the size of the recharge area and the storage characteristics of the karst aquifer. Most springs have maximum discharges that are 5 to 10 times greater than their average discharges. A few springs have relatively steady discharges and show little response to local precipitation. These springs may have a relatively large recharge area, but the bedrock openings are likely small and cannot accept or transmit large quantities of water after major precipitation events. These springs are referred to as high-storage springs. At the opposite end of the spring spectrum are

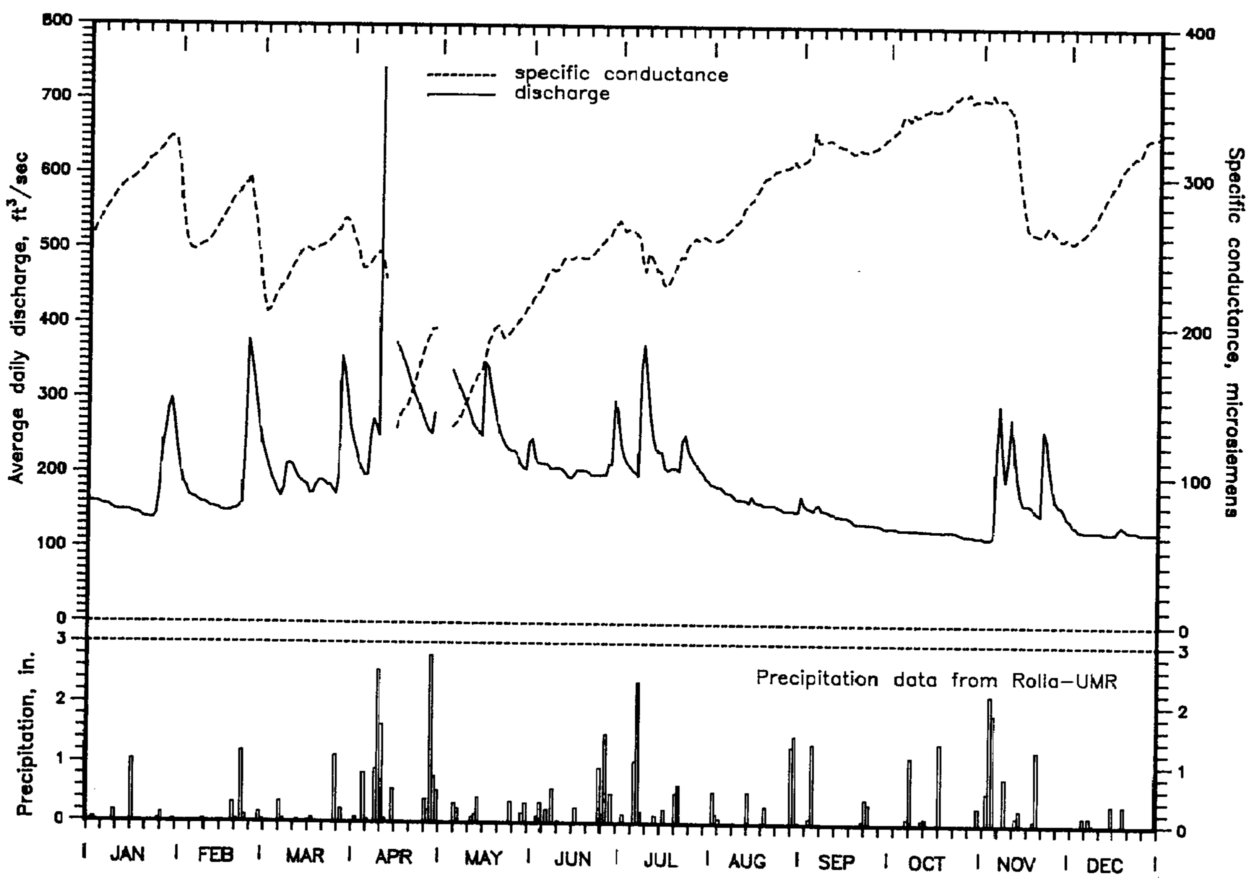


Figure 29. Discharge and specific conductance at Maramec Spring, and precipitation at University of Missouri—Rolla (from Vandike, 1996).

the high-transit springs that have little or no discharge during dry weather, but discharge large quantities of water briefly after heavy precipitation. High-transit springs are common in the Perryville area where extensive cave systems transport water from sinkhole plains to springs and karst resurgences. The karst resurgences are essentially overflow outlets. They are normally dry, functioning only after heavy rainfall. Some may discharge more than 100 ft^3/sec for a few hours after heavy rainfall, and a day later be completely dry.

A feature common in the southeastern Missouri area is the presence of thick residuum. Residuum is unconsolidated clay, silt and rock fragments that form from the weathering of the bedrock formations. Normally less than 20 feet thick in most of the Salem Plateau, residuum can exceed 200 feet in thickness in much of southeastern Missouri. Residuum is generally very permeable, and allows rapid downward movement of recharge. In essence, the residuum often acts as a storage medium; recharge water is stored in openings in the residuum after heavy precipitation and later released to bedrock aquifers.

GROUNDWATER CONTAMINATION POTENTIAL

The contamination potential at any location in the Salem Plateau groundwater province largely depends on the vertical hydraulic conductivity of the formations at or near land surface. Pennsylvanian-age bedrock overlies the Ozark aquifer in a small area of the north-central part of the province and provides fairly adequate protection from contamination sources. The siltstone, shale, and low permeability limestone and sandstone layers act as natural barriers in preventing downward movement of contaminants.

Jefferson City-Cotter dolomites, and the upper Gasconade Dolomite tend to be dense, and only moderately permeable. Though generally fractured, the fractures are typically not well interconnected and appreciably enlarged by the dissolution of the carbonate rock. Contaminants entering these formations tend to move slowly. However, due to the relatively low permeability and slower rate of recharge in these formations, contaminants introduced into them are also flushed slowly from them.

Where at or near land surface, highly permeable formations such as the Roubidoux Formation, the lower Gasconade Dolomite (including the Gunter Sandstone Member), and the Potosi Dolomite can easily become contaminated due to surface activities. With rare exception, these formations pose significant limitations on the development of most types of waste-disposal systems. Since these units also commonly host losing streams, sinkholes and other karst features, contaminants introduced into groundwater in discrete recharge settings can affect groundwater quality at springs a considerable distance away. Although groundwater in these settings can easily be contaminated, once the source of contaminantion is removed or the contaminants treated, water quality normally recovers quickly. For example, a November 1981 pipeline leak in a losing-stream watershed in southern Phelps County caused serious water-quality problems at Maramec Spring 12 miles northeast of the spill site. An estimated 24,000 gallons of liquid fertilizer containing ammonium nitrate and urea entered the subsurface in a losing reach of Dry Fork where the channel is developed in the lower Gasconade Dolomite. Although a large quantity of liquid fertilizer was spilled, it moved quickly through solution-enlarged bedrock openings, and within a few weeks was no longer detectible at the spring. It is interesting to note that although this spill severely affected water quality at Maramec Spring for several weeks, none of the several hundred private domestic wells in the area between the spill site and Maramec Spring were found to be affected (Vandike, 1982).

Contaminants entering conduit systems supplying major springs tend to follow very localized, well-defined flow paths. Had this spill occurred in a diffuse recharge upland setting, Maramec Spring would likely not have been severely affected because the contaminants would have reached the spring over a far

longer period of time. Instead of affecting groundwater quality for only a few months, a major spill in a diffuse recharge setting may have affected groundwater quality for months or even years.

Ordovician-age dolomites and sandstones form the bedrock surface over most of the Salem Plateau groundwater province, and are tapped by most of the thousands of domestic and farm wells in the region. Statistically, it is these wells that are most often affected by surface activities and poor waste disposal practices. This is due in part to how private wells are constructed. Prior to passage of the Water Well Drillers Act (RSMo 256.600-256.640) in 1985, there were no laws, rules or regulations governing the drilling of water wells or the construction of private wells; however, the construction of public water supply wells has been regulated in Missouri for many years. Private wells, especially those constructed prior to 1987, when water well drilling regulations became effective, are constructed to much less stringent standards than public water supply wells. Most older private wells contain less than 80 feet of casing that is not effectively sealed to preclude contaminants from entering the well from around the outside of the casing. Another reason that private wells are more likely to become contaminated is that they typically produce from relatively shallow aquifer zones. In a setting such as the Salem Plateau, shallow aquifer zones are much more likely to be affected by surface activities than deeper aquifer zones.

The deeper Cambrian-age formations provide much of the population of the area with water through municipal or public water-supply wells. These wells are cased much deeper than private wells; their casings are sealed full length with cement grout, and the aquifer zones they produce from are not at or near land surface over most of the province. Still, reasonable caution is necessary to prevent contamination of these units. Any prospective disposal site, such as a landfill or lagoon, should have a thorough geological evaluation to determine the probable effects on groundwater quality.

THE SPRINGFIELD PLATEAU GROUNDWATER PROVINCE

INTRODUCTION

The Springfield Plateau groundwater province in Missouri covers all or parts of 27 counties in the southwestern and west-central part of the state, and includes an area of about 8,900 square miles. It is bounded on the east by the Eureka Springs escarpment, to the northwest by the freshwater-salinewater transition zone, and to the south and southwest by parts of Arkansas, Oklahoma, and Kansas. Thick dolomites and sandstones comprising the St. Francois, Ozark, and Springfield Plateau aquifers underlie the region. In terms of importance for groundwater supplies and volume of fresh water in storage in consolidated-rock aquifers, this province ranks second in importance as a groundwater resource base.

Exposed bedrock units in this province range in age from Lower Ordovician through Pennsylvanian, but Mississippian-age limestone units form the bedrock surface in about 90 percent of the province (table 10). Most of the Cambrian and Ordovician formations that underlie the Salem Plateau are present in the subsurface in the Springfield Plateau, but may not crop out at the surface.

GEOLOGY

The main geologic difference between the Springfield Plateau groundwater province and the Salem Plateau groundwater province is the presence of a thick sequence of Mississippian-age rocks that overlie older Ordovician strata in southwestern Missouri. The Mississippian rocks, being primarily limestones, weather somewhat differently than dolomites, and present a different type of karst development than what is seen in the Salem Plateau. Karst development is at least as common here as in the Salem Plateau, but individual karst drainage systems are not as widespread. There are no first magnitude springs in the Springfield Plateau groundwater province, and relatively few second magnitude springs. Caves are common in many of the counties, and many are still active groundwater conduits. A higher proportion of the caves in the Springfield Plateau are entered from sinkholes than in the Salem Plateau.

In many ways, the Springfield Plateau landscape appears to be younger than that of the Salem Plateau. Karst development has had a profound impact on the formation of surface features, but the solutional activity, which produces karst features, probably started much later here than in the Salem Plateau. The Mississippian-age strata in southwestern Missouri were overlain by relatively impermeable Pennsylvanian-age sedimentary deposits for a longer period than the Ordovician-age rocks in the Salem Plateau were covered by younger sediments. There are limited parts of the Salem Plateau groundwater province that were capped by relatively impermeable bedrock that helped prevent extensive bedrock weathering. In general, though, surface weathering has apparently been in progress longer in the Salem Plateau than in the Springfield Plateau. As a result, the subsurface conduit systems in the Springfield Plateau typically

System	Series	Group or Formation	Thickness (In Feet)	Lithology	Hydrology	Remarks
Pennsylvanian		Undiff. Penn. Strata	1-120	Siltstone, sandstone, shale and thin limestone.	Not a significant aquifer	Western Interior Confining Unit
Mississippian	Meramecian	Warsaw Fm. and younger Mississippian Strata	200 (?)	Alternating limestone and shale formations.	Not a significant aquifer	Springfield Plateau Aquifer
	Osagean	Burlington-Keokuk Limestone	100-200	White to gray, medium- to coarse-crystalline, medium- to thick-bedded limestone. Relatively young karst features.	Small to moderate yields (10-30gpm) in Springfield Plateau province. Locally, where more deeply buried in western part of province, may yield as much as 100 gpm.	
		Elsey Formation	Average-30	Similar to Reeds Spring Fm., but chert is white and is mottled with round spots.		
		Reeds Spring Formation	0-100	Alternating beds of finely-crystalline limestone, and sandy chert. Unit is about 50% chert.		
		Pierson Limestone	5-55	Medium- to massively-bedded limestone, cherty limestone.		
	Kinder-hookian	Northview Formation	2-80	Lower part is greenish gray shale, upper part is siltstone.	Acts as aquiclude to separate Springfield Plateau Aquifer from Ozark Aquifer.	Ozark Confining Unit
		Sedalia Formation	0-50	Similar to Compton Formation, but more thickly-bedded. Interfingers with Compton.	Not water bearing	
		Compton Formation	5-30	Finely-crystalline, crinoidal limestone. Thin-bedded with greenish shale beds.		
Devonian	Late	Chattanooga Shale	0-30	Fissile, black, carbonaceous, sandy shale. Has oily or bituminous odor.	Could cause water quality problems if left uncased in wells. Contained water is high in sufates and may have H_2S gas.	
Ordovician	Canadian (lower)	"Powell" Dolomite	0-80	Fine- to medium-crystalline dolomite.	Not considered to be important aquifers. May yield 10 to 20 gpm locally to private, domestic wells.	Ozark Aquifer
		Cotter Formation	175-400	Lithology similar to Ozark Province.		
		Jefferson City Formation	Average-210	Silty dolomite, bedded oolitic chert.		
		Roubidoux Formation	140-210	Less sandstone than Ozark Province (only 10%). Primarily a cherty dolomite.	Yields 60-200 gpm	
		upper Gasconade Dolomite	40-70	Chert-free, medium-crystalline dolomite.	Probably yields 30 to 100 gpm in the province.	
		lower Gasconade Dolomite	240-335	Cherty dolomite, may contain 60% chert.		
		Gunter Ss. Member	Average-30	Sandy dolomite-30% to 50% sand.	Yields 25 to 150 gpm	
Cambrian	Croixian	Eminence Dolomite	0-340	Lithology becomes like Potosi Dolomite from east to west across province.	Yields 50 to 150 gpm	
		Potosi Dolomite	0-50	Lithology unchanged from Ozark Province. Interfingers with Eminence Dolomite.	Yields as high as 1,200 gpm. Range in yield 400-1,200 gpm, average 600 gpm.	
		Derby-Doerun Dolomite	0-50	Thins to the west, may be absent at the state line. Similar to Ozark Province.	Yields 30-50 gpm locally	
		Davis Formation	0-100	Similar to Ozark Province, but less shale, more limestone to the west.	May yield 10-30 gpm in western part of province. Locally a confining unit.	St. Francois Confining Unit
		Bonneterre Dolomite	0-380	Thins to the west, may be absent at state line.	Yields are probably 10-20 gpm.	St. Francois Aquifer
		Lamotte-Reagan Sandstone	0-350 Average 200	Similar to Ozark Province, less arkose in lower part. Transgressive to west.	Yields 100-200 gpm	
Precambrian				Igneous & Metamorphic rocks	Not an aquifer	Basement Confining Unit

Table 10. Stratigraphic section of the Springfield Plateau groundwater province.

drain smaller areas than those in the Salem Plateau, and the thickness of residual material produced by weathering is less.

Structural features such as faults, folds, and fractures are much more apparent in the Springfield Plateau groundwater province than in the Salem Plateau groundwater province. Although it is recognized that the Salem Plateau has undergone intense structural deformation, deep weathering has developed thick mantles of residual materials that obscure the surface view of many structural features. This deep weathering is absent in the Springfield Plateau, and here it is much easier to see geologic structures. Figure 30 shows the locations of major faults in the Springfield

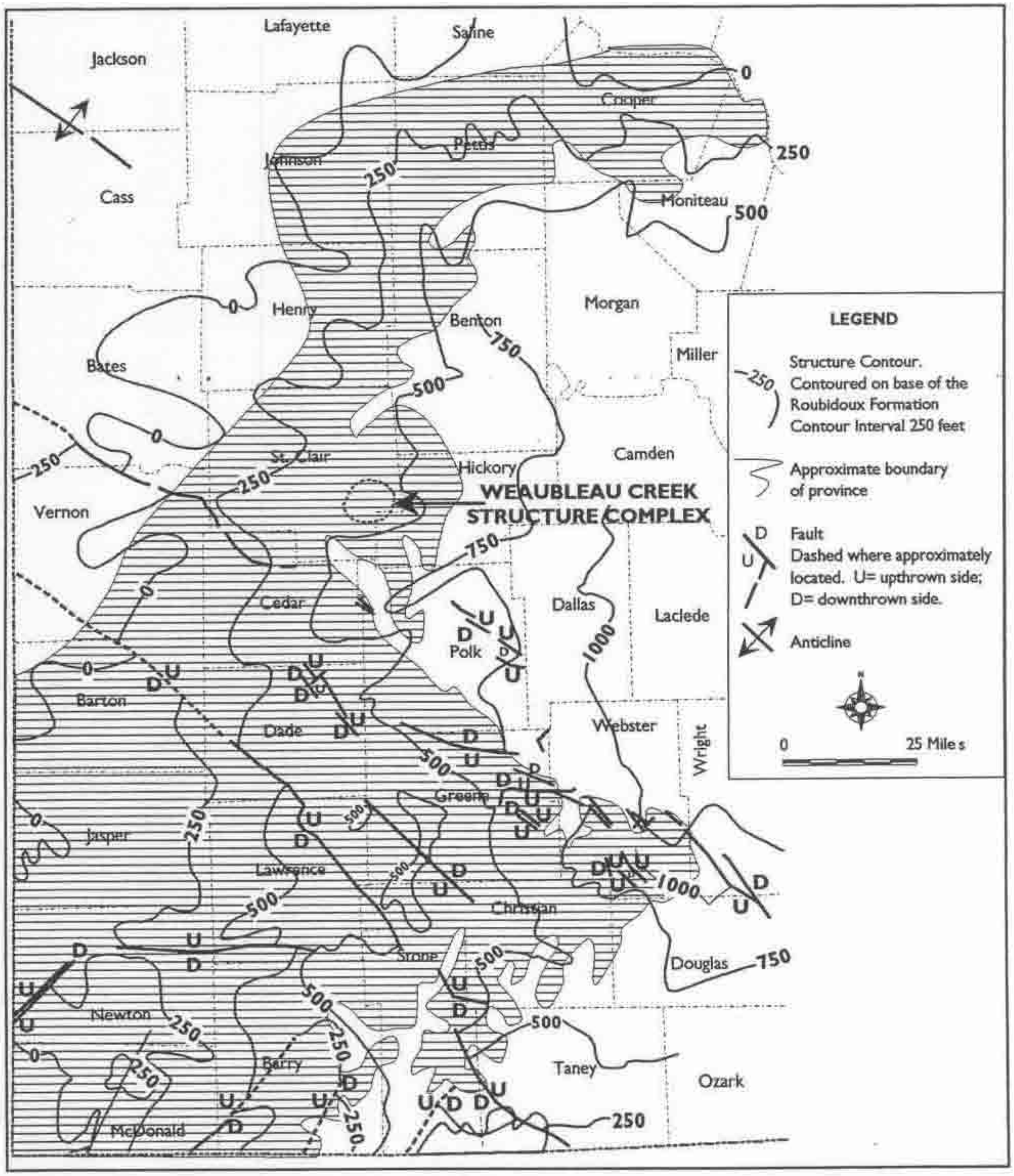


Figure 30. Structural map of the Springfield Plateau groundwater province (from McCracken, 1971).

Plateau. Faulting is commonly the result of crustal movements, and displaces adjacent blocks or bodies of rock in relation to one another. This displacement causes shattering and fracturing of the rock units adjacent to the fault plane. The larger the fault, the larger the area of shattered rock. Wells constructed along or adjacent to major fault systems generally have higher yields than normal, but they are also more likely to encounter weathered materials such as mud or clay, and have either construction or water-quality problems.

Precambrian System

Like in the Salem Plateau, Precambrian igneous and metamorphic rocks underlie the Paleozoic sediments throughout the Springfield Plateau groundwater province. Also, like the Salem Plateau, the Precambrian rocks are not considered to be an aquifer, and form the Basement confining unit.

Cambrian System

Lamotte/Reagan Sandstone

The Lamotte Sandstone is Late Cambrian in age and is the basal clastic unit throughout much of the Springfield Plateau groundwater province. However, in part of southwestern Missouri a second stratigraphic name, the Reagan Sandstone, is used instead of Lamotte. The stratigraphic term "Lamotte" originated in southeastern Missouri around the St. Francois Mountains area while the term "Reagan" originated in Johnson County, Oklahoma. Both names are used to describe a laterally continuous sandstone unit that extends across southern Missouri into Oklahoma and Kansas. The Lamotte and Reagan were deposited in a sea that was transgressing from east to west. Both rest unconformably on Precambrian igneous and metamorphic rocks, but the sandstone was deposited in the eastern part of the province before it was deposited in the western part. Thus, in the eastern part of the province the sandstone is much older than it is to the west.

If one uses standard stratigraphic methods and adheres to the Stratigraphic Code, it would seem almost unthinkable to give two separate stratigraphic names to what appears to be one continuous formation, especially since the lithology does not appreciably change. The major difference between the two is that across southwestern Missouri from east to west, the unit is progressively overlain by younger rocks and the sandstone itself is progressively younger.

A formation can cross time lines and still be considered the same formation, so there appears to be little reason for the name change. However, in southwestern Missouri there are certain economic geology considerations that encourage distinguishing between the two. Several years ago, test drilling for lead and zinc mineralization was actively occurring in southwestern Missouri. Mineral companies were interested in the area where the Lamotte Sandstone is overlain by the Bonneterre Formation. The Bonneterre is commonly the host rock of Mississippi Valley Type ore deposits, and if the Bonneterre Formation is missing there is little potential for the discovery of economically valuable minerals. Carbonate rock of the Bonneterre Formation was being deposited in the eastern part of this region at the same time that sandstone was being deposited in the western part. Essentially, from east to west across the region, the Bonneterre Formation thins and is replaced by sandstone. The name "Reagan Sandstone" is used in Missouri to designate the basal Cambrian sandstone unit in the western part of the area where the Bonneterre Formation is absent. The name "Lamotte Sandstone" is used for the basal Cambrian sandstone unit in the eastern part of the province where it is overlain by Bonneterre Formation.

Although the name change may be significant in terms of mineral exploration, hydrologically the name change means very little. The Lamotte and Reagan appear to have similar hydrologic characteristics.

Bonneterre and Davis Formations and Derby-Doerun Dolomite

The lithologies or general rock characteristics of these units where they are present in southwestern Missouri are essentially the same as in the Salem Plateau. The Bonneterre is primarily a dolomite unit, the Davis a carbonate and silty, shaley carbonate, and the Derby-Doerun

a dolomite. One major exception to this is that the Davis Formation becomes less shaley and contains more limestone and dolomite in the western part of the state. In the Salem Plateau, the Davis is considered a regional aquitard due to its high shale content and subsequent low vertical permeability. In the west, where it grades to a carbonate, it may have higher vertical permeability and allow greater interchange of water between zones above and below it.

The Bonneterre, Davis, and Derby-Doerun thin from east to west across the Springfield Plateau, and may be locally absent in extreme western Missouri.

Potosi Dolomite

The Potosi Dolomite thins from east to west across the Springfield Plateau, and locally interfingers with the overlying Eminence Dolomite to produce an alternating repetition of lithologies with depth. Where present, the interval in which this interfingering occurs averages 25 to 30 ft thick. Elsewhere, where the normal sequence of rock is present, the Potosi ranges in thickness from 0 to approximately 50 ft. The overall lithology of the unit is unchanged from the Salem Plateau, being a fine- to medium-crystalline, massive- to thickly-bedded, brownish-gray dolomite that exhibits vugs or small cavities filled with quartz druse.

Eminence Dolomite

The Eminence Dolomite thins from east to west across southwestern Missouri. At Springfield, the unit is composed of about 340 ft of light-gray, fine- to medium-crystalline dolomite that generally contains less than 5 percent chert. It appears that the Eminence thickens at the expense of the underlying Potosi Dolomite, which here, is only 45 ft thick. At Noel, in McDonald County at the extreme southwestern corner of the state, a mineral exploration test hole encountered the Eminence at a depth of 1,475 ft. The unit had thinned to only 115 ft, but the underlying Potosi was found to be 70 ft thick. The lithologies of the two units are quite similar in the western part of the Springfield Plateau groundwater province.

Ordovician System

Gasconade Dolomite and Gunter Sandstone Member

As in the Salem Plateau, the Gasconade Dolomite in the Springfield Plateau is informally divided into the upper and lower Gasconade Dolomites, and the Gunter Sandstone Member. The Gunter Sandstone Member of the lower Gasconade Dolomite has an average thickness in the Springfield Plateau of approximately 30 ft. It is the lowermost rock unit of Ordovician-age in the province. As in the Salem Plateau groundwater province, the Gunter conformably overlies the Eminence Dolomite. Over much of the province, it is composed of sandy dolomite, which ranges in sand content from about 20 to 100 percent. There are some instances where the unit contains thin beds of dolomitic sandstone, but this occurrence is rare. There does not seem to be any uniform tendency for this unit to thin appreciably from east to west as with the underlying units.

The lower Gasconade Dolomite conformably overlies the Gunter Sandstone. The unit ranges in thickness in southwestern Missouri from about 335 ft on the eastern side of the province near Springfield in Greene County, to about 240 ft in central McDonald County at the extreme southwestern corner of the state. In the eastern part of the Springfield Plateau, the upper 100-ft of the lower Gasconade typically has a high chert content, locally as much as 60 percent. In the western part of the province, however, the thickness of the chert-rich interval increases to include the upper 175 ft of the formation, but the total percentage of chert in the rock decreases somewhat.

The upper Gasconade Dolomite conformably overlies the lower Gasconade in the Springfield Plateau. It ranges in thickness, east to west across the province, from approximately 40 ft to 70 ft. Unlike the lower Gasconade, the upper Gasconade is relatively chert-free, consisting primarily of fine- to medium-crystalline, grayish-brown dolomite. The thinning of both upper and lower Gasconade dolomites is quite likely the result of the transgression of the early Ordovician sea from

east to west across the state, and the resulting shortened time span during each depositional phase.

Roubidoux Formation

The Roubidoux Formation in the Springfield Plateau loses many of the lithologic characteristics that typify it in the Salem Plateau. In the Salem Plateau, the term Roubidoux is synonymous with sandstone. In the Springfield Plateau, however, the Roubidoux is predominantly a cherty dolomite, and generally contains only scattered beds of dolomitic sandstone. Whereas sandstone may comprise 50 to 75 percent of the Roubidoux in the Salem Plateau, the Roubidoux in the Springfield Plateau may only constitute 10 percent of the total rock.

Jefferson City, Cotter and "Powell" Dolomites

The Lower Ordovician-age Jefferson City Dolomite conformably overlies the Roubidoux Formation in southwestern Missouri. Its thickness remains relatively constant across the province at about 210 ft. The unit consists of dolomite and cherty dolomite. It is recognizable in the subsurface from drilling samples by the presence of oolitic cherts. Oolites appear as very small, clustered spheroids within the chert.

Conformably overlying the Jefferson City is the Cotter Dolomite. The Cotter ranges in thickness in the Springfield Plateau from 175 ft in the east to 400 ft in the west. Its lithology is similar to that found in the Salem Plateau. It consists of dolomite and cherty dolomite with minor sandstone beds and thin partings of green shale. A most notable sandstone bed, termed the "Swan Creek," is some 3 ft to 15 ft thick. The Cotter is the oldest formation that crops out in the Springfield Plateau.

The "Powell" Dolomite is present in the subsurface of the Springfield Plateau groundwater province in the extreme southwestern part of the state where it consists of medium- to finely-crystalline dolomite with thin beds of green shale and fine-grained sandstone. Where present, it is a maximum of about 80 ft thick. It is Lower Ordovician (Canadian) age, and conformably overlies the Cotter Dolomite.

Devonian/Mississippian System

Chattanooga Shale

The Chattanooga Shale of late Devonian-age unconformably overlies the Jefferson City-Cotter-"Powell" sequence in the southwestern part of the Springfield Plateau groundwater province. Where present, the Chattanooga is a fissile, black, carbonaceous, sandy shale. It locally exhibits an oily or bituminous odor. Some wells penetrating the unit have encountered small quantities of free oil. The unit is thickest in McDonald County where it achieves a maximum thickness of about 30 ft. A few miles to the east in southern Barry County it thins to approximately 10 ft. It is absent throughout much of the eastern and northern part of the Springfield Plateau.

Mississippian System

Compton Limestone, Sedalia Formation and Northview Formation

These formations are all included in the Chouteau Group, a sequence of Lower Mississippian-age rocks that show considerable variability in the Springfield Plateau. The Compton is a very finely-crystalline limestone, which has an abundance of finely-distributed crinoid fragments, and ranges in thickness from 5 ft to 30 ft. It is typically thin-bedded with greenish-gray shale interbeds between the limestone beds. The unit may be locally dolomitic, and where this is the case it is usually massive in appearance. The lower part of the formation is sandy in the eastern part of the province, and becomes more argillaceous or silty to the west. The Compton and the underlying formations are separated by a major unconformity.

The Sedalia Formation conformably overlies the Compton in the northern part of the province. The lithology of the Sedalia is quite similar to that of the underlying Compton, the main differences being that the Sedalia is more dolomitic, thickly-bedded and has more chert. It reaches a maximum thickness of about 50 ft in west-central Missouri. Southward from western Pettis County, the unit thins greatly, and seems to interfinger with the overlying Northview Formation (Howe, 1961). It disappears from the rock sequence to the south in Cedar County.

The Northview Formation conformably overlies the Sedalia where it is present, and also the underlying Compton due to the interfingering of the Compton and the Sedalia mentioned above. In the Greene and Webster county area it consists of two separate units, a lower shaley unit and an upper, predominantly siltstone unit. This is also one of the areas in which the Northview is at its thickest, attaining a maximum thickness of about 80 ft. In fact, this extreme thickness is part of northwest trend that extends from Greene County to Barton County. The unit thins to the north and south of this trend, and averages less than 5 ft in thickness in the northern and southern tier of counties in the province.

This Northview Formation has a highly variable lithology, ranging between greenish-brown siltstone to green, silty clay from one locality to the next. As it thins north and south from the previously mentioned trend, it becomes progressively more shaley to the north and more calcareous to the south.

Pierson Limestone, Reeds Spring Formation, Elsey Formation, and Burlington-Keokuk Limestone

The Pierson Limestone in the Springfield Plateau conformably overlies the Northview Formation, and is of Osagean- or middle Mississippian-age. It ranges in thickness from less than 5 ft to as much as 55 ft in the southern part of this province in Stone and Barry counties.

The Pierson is a medium- to massively-bedded limestone containing abundant chert in the upper part. Locally, the unit is composed of cherty, dolomitic limestone. Where the unit is thinnest, the cherty interval is missing.

The Reeds Spring Formation has an average thickness of about 100 ft in the southwestern part of the province, but thins to the northeast. In the Springfield area, the unit is only about 30 ft thick. It is absent north of the Springfield area. The Reeds Spring is composed of alternating beds of finely-crystalline limestone and dark-gray, sandy chert. Throughout its depositional area, the Reeds Spring contains almost equal amounts of limestone and chert, and in the upper part of the formation chert is the predominant lithology.

The Elsey Formation conformably overlies the Reeds Spring, and lithologically is similar to it. They differ mainly in the type of chert they contain. The Elsey has white to grayish-white chert, which has brown mottled patches and large circular spots. Many workers simply combine the two formations because of their similarity, and call the combined unit the Elsey-Reeds Spring Formation. The Elsey has an average thickness of about 30 ft.

The Burlington and Keokuk limestones conformably overlie the Elsey in the Springfield Plateau province. They are both medium- to coarsely-crystalline limestones that are white- to light-gray and medium- to thickly-bedded. Crinoid fossils are abundant in both units, and in places the limestone is mostly composed of fossil fragments. The Keokuk, which overlies the Burlington, is slightly finer-grained and contains more chert, particularly in the lower part. Otherwise, the two units are so similar that workers usually combine the two in discussions. The Burlington-Keokuk ranges in thickness from 200 ft, near Springfield in Greene County, to approximately 100 ft near Joplin. To the south in southern Barry County, the Burlington pinches out, leaving only the Keokuk present.

Much of the karst development in the Springfield Plateau is in the Burlington-Keokuk Limestone. Most of the major caves, springs, sinkholes and losing streams are developed in this stratigraphic interval. The karst in southwestern Missouri appears younger than that in the Salem Plateau, and unlike the karst weathering to the east, karst weathering in the Springfield Plateau has not produced the thick residual cover that typifies the Salem Plateau in southeastern Missouri. Nonetheless, numerous caves, sinkholes, springs and losing streams are present in the southwestern part of the state.

In many locations where the Burlington-Keokuk are the shallowest bedrock units, their upper surface has weathered very unevenly into cutters and pinnacles (figure 31). Pinnacles stand in relief above the intervening

gulleys or cutters. The cutters typically coincide with joints, along which there has been solutional weathering. The pinnacles are essentially the bedrock pillars between the cutters, and are locally 8 to 10 ft high and a few feet to a few 10s of feet across. Travelers in southwestern Missouri can see this type of feature in the Springfield area, particularly along Interstate 44 along the northern part of the city, and also along its eastern margin on U.S. Highway 65.

Other Mississippian-Age Formations

Mississippian-age formations overlying the Burlington-Keokuk interval are of little importance with regard to their groundwater possibilities. A possible exception is the Warsaw Formation, which directly overlies the Burlington-Keokuk. The lower Warsaw consists of fossiliferous limestone much like the underlying Burlington-Keokuk. The upper part of the formation is a calcarenite, and is composed of sand-size calcium carbonate grains. The unit is 150 ft thick or more in the Tri-State district in Jasper and Newton counties, but is typically much thinner. Overlying the Warsaw is a thin sequence of Mississippian rocks, which directly underlay rocks of Pennsylvanian-age. These rocks are not considered significant water-yielding units. They

Figure 31. Cutters and pinnacles in the Burlington-Keokuk Limestone along U.S. Highway 65 in Springfield. Photo by Jim Vandike.

may, however, yield small quantities of water to private wells drilled through them.

PENNSYLVANIAN SYSTEM

Undifferentiated Pennsylvanian Strata

Rocks of Pennsylvanian age form the bedrock surface in the western part of the Springfield Plateau groundwater province. In terms of physiography, the areas underlain by Pennsylvanian-age strata in this area are within the Osage Plains physiographic province. However, since the deeper aquifers in Mississippian-, Ordovician-, and Cambrian-age rock yield potable water for several miles into the Osage Plains, part of it is included in the Springfield Plateau groundwater province.

Pennsylvanian-age rocks are described in many measured stratigraphic sections, have been logged in many wells, and consist of several formally described stratigraphic units. However, in this report the Pennsylvanian formations will not be discussed individually, but instead will be discussed as a group of undifferentiated rocks. The Pennsylvanian strata range in thickness from a feather edge at their cropline, to as much as 120 ft at their western extent in the province. They are composed of sequences of siltstone, sandstone, shale and thin limestone. Locally, the shale and siltstone sequences have thin coal beds.

HYDROGEOLOGY

BASEMENT CONFINING UNIT

As in the Salem Plateau groundwater province, the thick sequence of Paleozoic rocks in the Springfield Plateau rest upon Precambrian igneous and metamorphic rock. The Precambrian rocks are mostly crystalline, and have essentially no effective porosity or permeability. They form a lower confining unit for the St. Francois aquifer that precludes further downward movement of water below that aquifer.

ST. FRANCOIS AQUIFER

As in the Salem Plateau, the St. Francois aquifer in the Springfield Plateau consists of the Bonneterre Formation and the Lamotte/Reagan Sandstone. However, because of its depth and the generally adequate yields from shallower zones, few communities in the Salem Plateau groundwater province presently make use of the St. Francois aquifer.

One town that does is the city of Sedalia, which has four wells penetrating the Lamotte. A fifth well was planned to finish in the Lamotte, but went directly from the Bonneterre Dolomite into Precambrian basement rocks; the Lamotte Sandstone was absent at that location. At Sedalia, the Lamotte increased the overall yield of the wells, which also produce from the Ozark aquifer, an additional 100 to 200 gpm above the average of 450 gpm obtained from shallower horizons. These wells ranged in depth from 1,460 ft to 1,665 ft, with the average thickness of the Lamotte being about 220 ft. Similar yields are likely possible from the Lamotte/Reagan in other areas of southwestern Missouri.

The city of Carl Junction in Jasper County has completed two wells that penetrate the Lamotte/Reagan. As in Sedalia, yields from shallower zones were less than desired, and the additional production from the deeper aquifer increased the total yield more than 100 gpm.

The Lamotte is missing in several places in western and southwestern Missouri. One such location, recently discovered, is at the extreme eastern edge of the Springfield Plateau just northeast of Warsaw in Benton County. Here, the Missouri Department of Conservation recently finished several high-yield wells that will supply a large fish hatchery. Most of the wells penetrated the normal Ozark aquifer sequence, but at least one well encountered granite at a relatively shallow depth, less than 1,000 ft. The granite was directly overlain by Potosi Dolomite; the Davis, Bonneterre, and Lamotte (Reagan) formations were absent.

The Bonneterre Formation, Davis Formation, and Derby-Doerun Dolomite are present in places in the Springfield Plateau, but are generally poor water-yielding units. There are instances when deep wells scheduled to fully penetrate the Ozark aquifer bottom in the

middle part of the Derby-Doerun. Locally, small amounts of water are encountered but not more than 30 to 50 gpm. In most areas, though, there is no appreciable addition of water from the Derby-Doerun.

In the Springfield Plateau, the Davis Formation has less shale than areas to the east, and because of this there may be greater interchange of water here between the Ozark aquifer and the St. Francois aquifer. However, so little information is available concerning the hydraulic relationship between the two aquifers that such theories are highly speculative.

The volume of usable groundwater contained in the St. Francois aquifer in the Springfield Plateau groundwater province is estimated to be about 4.1 trillion gallons, or about 12.6 million acre-ft.

OZARK AQUIFER

The Ozark aquifer in the Springfield Plateau consists of most of the same geologic units as to the east. In ascending order it consists of the Potosi, Eminence, and Gasconade dolomites, the Roubidoux Formation, and the Jefferson City, Cotter, and locally "Powell" dolomites. Figure 32 shows the thickness of the Ozark aquifer in the Springfield Plateau groundwater province. In terms of yield, this aquifer is the most prolific one in the southwestern part of the state, and provides for municipal, industrial, and agricultural water supply throughout the region. Joplin, Neosho and Springfield each use surface water to meet some if not most of their water-supply needs, but all of these cities also have wells penetrating the Ozark aquifer that are either emergency sources of water, or supplement their surface-water supplies.

The Ozark aquifer is a confined aquifer throughout most of the province. It is bounded below by the St. Francois confining unit, principally the Derby-Doerun Dolomite and Davis Formation, and above by the Ozark confining unit, consisting of the Chattanooga Shale, Compton Limestone, Sedalia Formation, Northview Formation, and Pierson Limestone. Fully penetrating Ozark aquifer wells in the Springfield Plateau generally yield from 200 to as much as 2,000 gpm. Yields are generally lowest in extreme western Missouri from Joplin south to McDonald County. Highest yields generally occur in the northwestern part of the plateau and in the Springfield area.

The quality of water produced from the Ozark aquifer is generally very good. It is a moderately-mineralized calcium-magnesium-bicarbonate type of water (table 11).

The Potosi interval, regardless of its lithologic character or thickness, is an important water-bearing horizon in the province. The Potosi is generally too deep for use as a water source for private domestic wells, but it is an important aquifer zone for high-yield municipal wells in the eastern part of the province. The city of Springfield in Greene County has several wells that fully penetrate the Potosi at depths averaging about 1,500 ft. These wells produce from zones between the Cotter and the base of the Potosi. Yields as high as 2,000 gpm are reported, but average yields are generally less than 1,000 gpm. West, south, and southwest from the Springfield area, the Potosi occurs at progressively greater depths. Very few water wells have been drilled into the Potosi outside of the Springfield area until fairly recently. Two Potosi wells were drilled in 1994 near Branson in southern Taney County at the eastern edge of the Springfield Plateau. Both wells encountered the base of the Potosi at a depth of nearly 2,000 ft, and had yields of more than 800 gpm. The reluctance to drill into the Potosi in southwestern Missouri where the unit is deeply buried is purely economical. The cost of drilling a 2,000-foot deep, large-diameter well containing 400 ft of pressure-grouted casing is cost prohibitive for most individuals as well as many smaller towns, industries and water districts, especially if sufficient quantities of water can be found at shallower depths.

Until recently, most high-yield Ozark aquifer wells in the Branson area bottomed in the lower Gasconade Dolomite or upper Eminence Dolomite. Yields from the intermediate-depth zones of the Ozark aquifer were sufficient. However, the recent rapid growth of the area has led to the construction of more

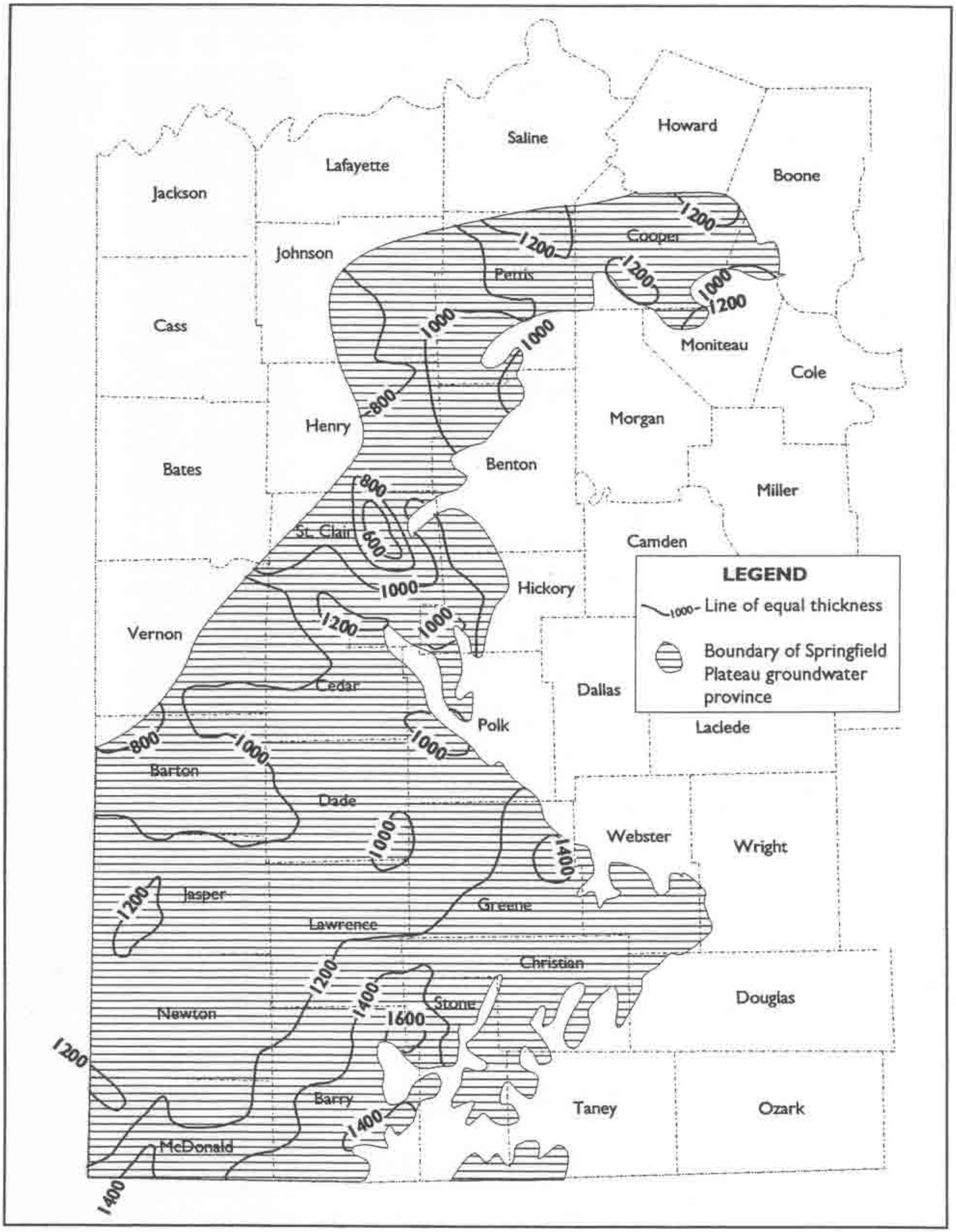


Figure 32. Map showing thickness of the Ozark aquifer in the Springfield Plateau groundwater province (from Imes, 1990).

City Water Supply	pH	Alkalinity	Iron	Manganese	Sodium	Potassium	Calcium	Magnesium	Nitrate	Sulfate	Chloride	Fluoride	Total Dissolved Solids	Total Hardness	Copper
Billings	7.8	173.	< 0.10	0.02	2.1	1.0	36.0	20.9	< 0.05	13.0	2.8	< 0.10	250.	176.	0.01
Branson	7.4	86.	< 0.10	< 0.02	2.9	1.8	32.9	4.7	0.18	11.0	8.0	< 0.20	182.	102.	0.05
Carthage	7.9	164.	< 0.10	< 0.02	10.2	1.9	23.7	16.6	< 0.05	-	-	0.26	-	150.	0.05
Clever	8.0	120,	0.15	0.03	1.6	1.0	28.6	15.1	< 0.05	14.0	< 2.0	0.11	162.	134.	0.01
Crane	7.7	180.	< 0.10	0.02	2.4	1.4	38.6	20.4	< 0.05	< 10.0	< 2.0	< 0.20	201.	180.	0.05
Galena	7.8	145.	< 0.10	< 0.02	1.3	1.1	29.2	17.6	< 0.05	11.0	< 2.0	< 0.20	159.	145.	0.05
Joplin	7.4	94.	< 0.10	< 0.02	4.9	2.6	40.4	2.2	2.20	14.0	11.0	< 0.20	146.	110.	0.05
Lamar	8.4	60.	< 0.10	< 0.02	23.0	5.0	31.9	5.0	< 0.05	91.0	10.0	0.64	217.	98.	0.05
Mindenmines	7.8	268.	< 0.10	< 0.02	80.0	5.2	39.3	17.1	< 0.05	15.0	66.0	0.97	399.	169.	0.13
Neosho	7.4	115.	< 0.10	< 0.02	9.9	4.0	50.6	3.4	2.10	17.0	15.0	< 0.20	190.	140.	0.05
Nixa	7.8	165.	< 0.10	< 0.02	2.0	1.4	38.5	19.8	< 0.05	10.0	2.0	0.10	218.	178.	0.01
Noel	8.0	125.	< 0.10	< 0.02	54.4	2.8	24.3	11.0	< 0.05	16.0	67.0	0.85	279.	106.	0.01
Ozark	7.9	135.	< 0.10	< 0.02	1.3	1.1	31.6	16.2	< 0.05	14.0	< 2.0	< 0.10	166.	146.	0.01
Pleasant Hope	7.7	164.	0.27	< 0.02	1.6	0.9	35.0	17.5	< 0.05	10.0	< 2.0	< 0.20	202.	160.	0.05
Republic	7.8	147.	< 0.10	< 0.02	3.2	1.4	35..3	16.8	< 0.05	10.0	< 2.0	1.00	173.	157.	0.01
Seligman	7.8	153.	< 0.10	< 0.02	2.2	1.1	40.2	19.3	< 0.05	25.0	< 2.0	< 0.10	230.	180.	0.01
Strafford	7.6	136.	< 0.20	< 0.02	2.9	1.2	31.8	15.5	< 0.05	16.0	2.0	< 0.10	174.	143.	0.01
Walnut Grove	7.8	148.	0.10	< 0.20	1.7	1.3	33.9	17.2	< 0.05	< 10.0	3.0	< 0.10	202.	156.	0.01

Analyses expressed in milligrams per liter (mg/L)

Table 11. Chemical analysis of water from selected Ozark aquifer wells in the Springfield Plateau groundwater province (from Department of Natural Resources, 1991).

and deeper Ozark aquifer wells, resulting in a lowering of groundwater levels in that aquifer in parts of western and southern Taney County. Drawdown has also locally decreased the saturated thickness of the Ozark aquifer, and thus its transmissivity. As transmissivity decreases, well yield decreases and drawdown increases, as does pumping cost since the water has be raised a greater vertical distance. Figure 33 is a hydrograph from city of Branson well #4, which has been used as a groundwater-level observation well since 1993. This well is about 2 miles from the major pumping area in Branson, but nonetheless shows seasonal water-level changes of more than 50 ft.

In terms of total water resources, southern Taney and Stone counties are relatively water-rich; Table Rock, Taneycomo and Bull Shoals lakes bisect the area. With the exception of the immediate Branson area where overproduction has caused a lowering of groundwater levels, groundwater resources are still excellent in this area. There is more than enough water to meet present and reasonable future demands; the problem is primarily with distributing the water. Groundwater has historically been used almost exclusively in this area because it was relatively inexpensive to obtain. Although drilling a deep, high-yield well suitable for public-water supply use is far from free, it is much less expensive than constructing a reservoir, or a pipeline to an existing reservoir, and building and maintaining a surface-water treatment plant. With few exceptions, raw water from the Ozark aquifer in this area requires no treatment to meet public drinking water standards.

The Ozark aquifer in southwestern Missouri is a confined aquifer, and except for a few areas where overproduction has lowered its potentiometric surface to below the base of the Ozark confining unit, water in an unpumped well will rise in the drill hole above the top of the aquifer. When a well is pumped, water-level in the aquifer adjacent to the well begins to decline. The rate of decline depends on the pumping rate, aquifer transmissivity and storativity coefficients, and how long the well is pumped. The drawdown is greatest in the pumped well, and decreases

with distance away from the well. This drawdown gradient extends in all directions away from the pumped well, and is roughly cone shaped. The terms *cone of influence, drawdown cone, cone of depression,* and *radius of influence* are all terms which describe the same phenomena (figure 34).

Currently in the Branson area, and historically in the Springfield area, the depression cones of numerous wells have coalesced to form a much larger, more regional drawdown cone—the result of pumping from numerous high-yield wells all producing from the same aquifer. The results are deeper pumping levels for all wells located within the cone, reduced yields for most wells, higher pumping costs to produce the same quantity of water, and the danger that water levels in some wells will drop below the effective depth to which pumps can be lowered. In the case of the Springfield or Greene County cone of influence, the geographic size of the cone is essentially the size of the entire county. Groundwater-level decline in the center of the pumping cone in Springfield is about 500 ft. In other words, during static or nonpumping conditions, the water level in a well in downtown Springfield is about 500 ft deeper than what it would have been prior to extensive groundwater usage. Most of the heavy pumping is done by industries that use large volumes of water, coupled with pumpage of municipal water in north Springfield.

The Branson area has only recently experienced the effects of extensive groundwater use and the resulting lowered groundwater

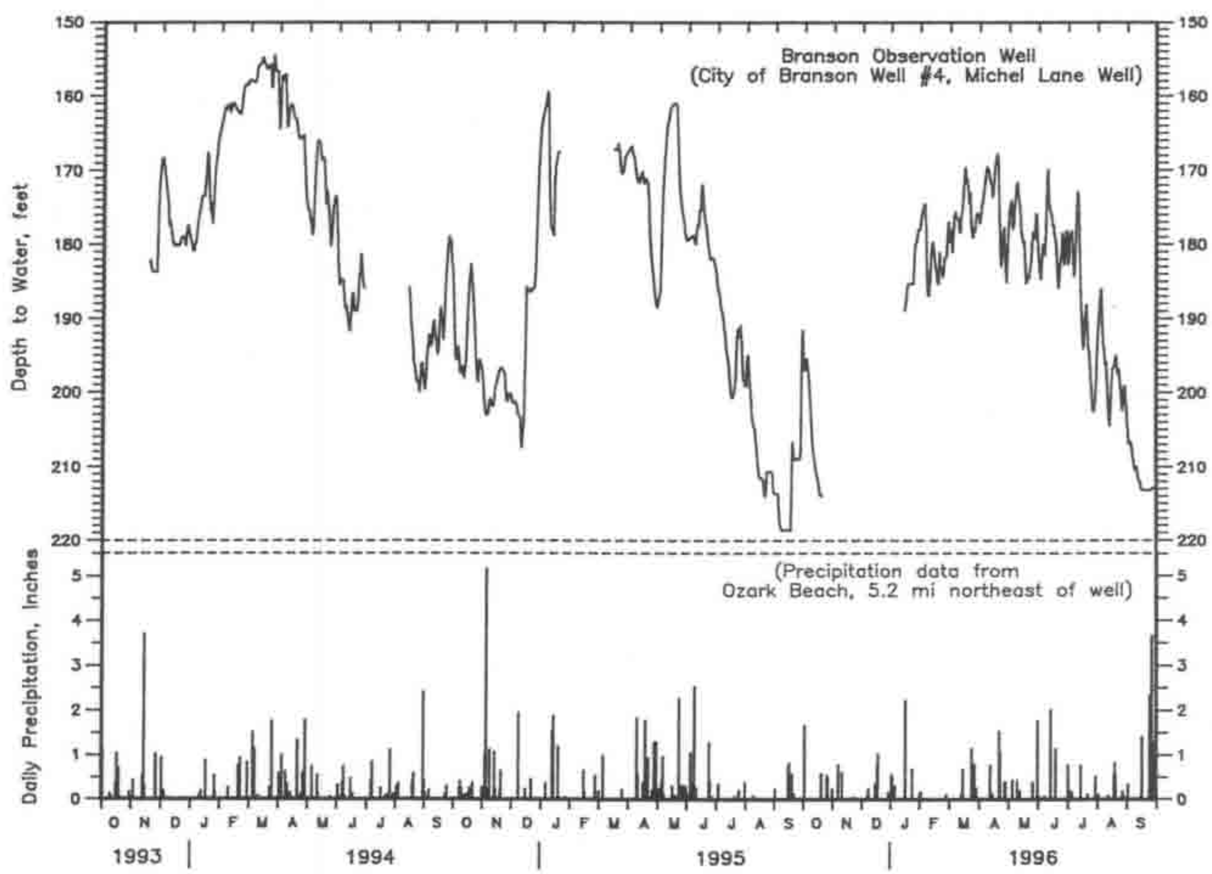


Figure 33. Groundwater-level hydrograph, Branson observation well, Taney County.

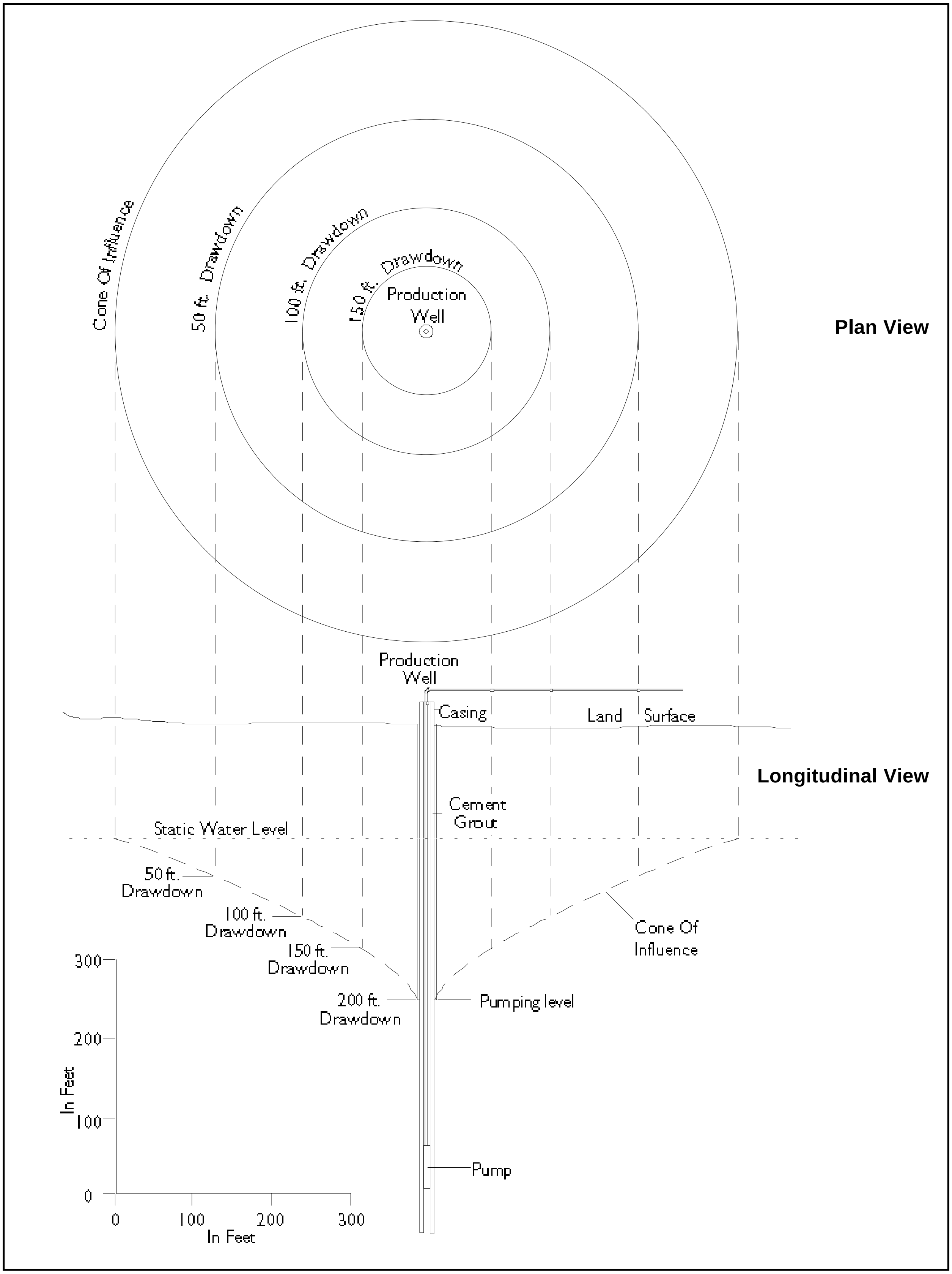


Figure 34. Idealized cone of influence from pumpage of a high-yield well.

levels. If this trend continues, the Potosi Dolomite will become increasingly important as a source for large volumes of water, regardless of the well construction costs.

Water quality from the Potosi Dolomite where utilized in the Springfield Plateau groundwater province is good, although total dissolved solids in carbonate aquifers tend to be high enough to have to classify them as high in carbonate hardness.

The Eminence Dolomite, although deeply buried in the Springfield Province, is not considered to be a prolific aquifer. The Eminence generally contributes only about 100 gpm to wells that penetrate it. The reason why this unit, which attains a thickness of more than 300 ft, should not have a higher yield is not clear. One reason may be that the Eminence has a low chert content, and has not developed the high fracture permeability needed to store and transmit large volumes of water. Units with a higher chert content such as the Roubidoux Formation, lower Gasconade Dolomite, and Potosi Dolomite, seem to transmit water more freely. This may be due to fracturing in chert beds that tend to have more open space, and which do not refill with precipitated calcium carbonate, as do fractures in limestone and dolomite. The precipitation of calcium carbonate in carbonate-rock aquifers is quite evident in many older wells where production has declined steadily over many years even though the nonpumping water levels in the wells remain nearly the same. Acidizing the wells using hydrochloric acid dissolves the precipitated carbonate, and normally restores production to its original value.

The Gunter, although relatively thin in comparison with the other aquifer units in the province, is a frequent target zone for many municipal wells. Yields of wells penetrating the unit range from 300 gpm to 500 gpm (figure 35). These values, however, are composite yields of all the formations the well is open to. Yields of water from the Gunter alone, probably range from 25 gpm to 150 gpm.

The lower Gasconade Dolomite is not typically a principal target zone for high-yield wells in the Springfield Plateau groundwater province. Very few wells are constructed to use only this formation as a source for water. Since it occurs at depths beyond the economic capabilities of domestic well owners, it is also not a zone that is used appreciably for low-yielding wells. However, since in all cases it is below the permanently saturated zone, and has a substantial thickness of fractured dolomite with good vertical and horizontal permeabilities, it probably ultimately contributes large volumes of water due to its storage capabilities. The ultimate yield of any deep well in the Ozarks is the sum of the yields of individual water-bearing zones. So, even though the lower Gasconade lacks the production necessary to make it an attractive target zone for high yield wells, it nonetheless contributes to the production of any well that penetrates it.

The upper Gasconade Dolomite is not considered an important aquifer unit in the province. Wells drilled through the upper Gasconade seldom encounter appreciable additional yield in the unit.

The Roubidoux Formation in the Springfield Plateau is a very important aquifer unit. Many high-yield wells supplying communities, industries and irrigation use the Roubidoux as a primary source. In some instances in the Springfield area, some private domestic wells are drilled into the Roubidoux. These wells are much deeper than is typical for private wells, but in some instances the Roubidoux is the first significant water encountered. It is the youngest and shallowest high-yielding zone in the Ozark aquifer (Imes, 1990). Ordovician-age rocks that overlie the Roubidoux are much less permeable, and generally cannot supply more than 40 to 50 gpm.

Yields of the Roubidoux in this province range from approximately 60 gpm throughout much of the region to as much as 200 gpm in the extreme southwest corner of the state. Yields from the Roubidoux in the Springfield Plateau groundwater province are higher than in the Salem Plateau for at least two reasons. First, the Roubidoux is more deeply buried

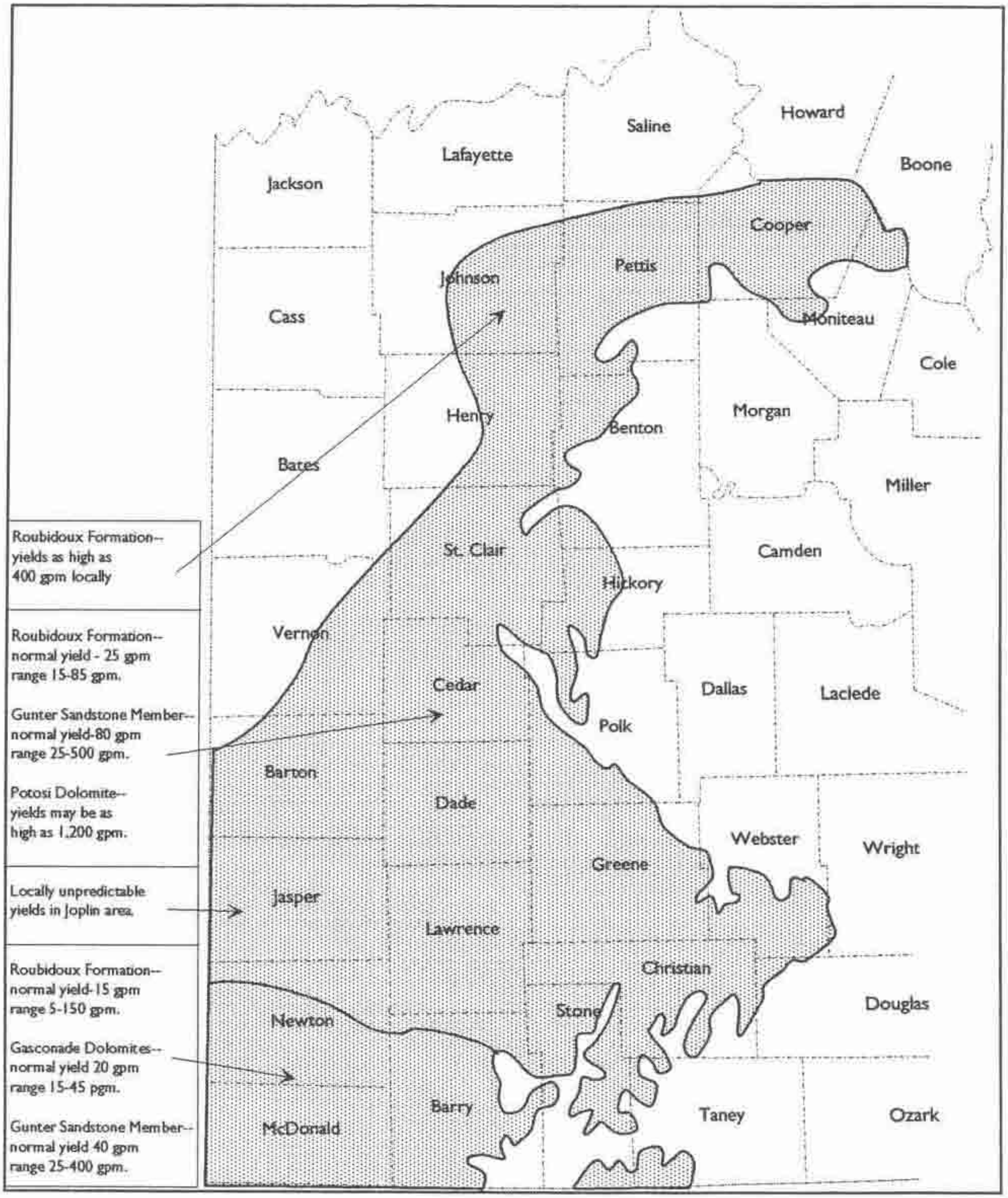


Figure 35. Yields of aquifers in Springfield Plateau groundwater province (modified from Knight, 1961).

and is well below the potentiometric surface in the Springfield Plateau, and is not as readily affected by local influences such as seasonal drought. In the Salem Plateau, the Roubidoux commonly crops out in major valleys, and groundwater gradients in shallow zones here are commonly controlled by topography. Hence, seasonal water-level fluctuations and natural drainage of the unit takes place. The second reason may be that the lithology of the unit in southwestern Missouri is much different than in most of the Salem Plateau. Here, it contains only minor amounts of sandstone, and the unit can develop greater secondary permeability due to dissolution of carbonate rock along fractures, bedding planes, and other discrete, interconnected openings. Sandstone beds in the Roubidoux are much less likely to develop high secondary permeability.

Water quality of groundwater contained in the Roubidoux is quite good. It is a calcium-magnesium bicarbonate type of water with total dissolve solids ranging between 250 mg/L and 350 mg/L.

The Jefferson City, Cotter, and "Powell" dolomites are widely used for domestic and farm water supply in southwestern Missouri, but are not considered to be high-yielding aquifer zones. They are penetrated by all high-yield Ozark aquifer wells drilled in the province, and may add a few gallons a minute to the total yield of the well. But most of the production is from the Roubidoux Formation, lower Gasconade Dolomite, Gunter Sandstone Member and Potosi Dolomite. Although many private domestic wells use the Jefferson City, Cotter, and "Powell" dolomites as a source of groundwater, there is no consistency in the capabilities of these units to yield water. All of the units have thin shale interbeds. Where the units have been fractured and subsurface weathering has occurred, there is commonly a great deal of fine, insoluble material left as a residual product. Quite possibly, any permeability created by fracturing of the rock is offset by the insoluble fines left behind by movement of water through the crevices. This same propensity for leaving large volumes of fines behind in the form of mud is very evident.

In the Springfield area, there is a major lithologic change in the Cotter Dolomite that deserves mention. In this area, there is a sandstone unit in the Cotter called the Swan Creek Sandstone that is capable of yielding from about 5 gpm to 25 gpm. Historically, many private domestic wells have been drilled into the Swan Creek. Most contain minimal casing to also take advantage of shallower water-bearing zones in the Mississippian-age rock. This practice has caused many problems, particularly in the Springfield area, where urbanization in the karst areas has caused contamination of the shallower aquifer zones. Since the Swan Creek wells contained little casing, contaminated groundwater was able to enter the wells and to locally cause contamination of the Swan Creek interval. For many years, it has been common practice to case public water supply wells below the Swan Creek Sandstone to help preclude contaminants from affecting the deeper wells. Today, private domestic wells in much of Greene and northern Christian counties must be cased below the Northview Formation to help prevent contamination of the Ozark aquifer in that area.

The direction of groundwater flow in the Ozark aquifer in the Springfield Plateau is controlled by the same factors that control flow in the Salem Plateau. Deep flow directions are generally to the west-northwest. Hydraulic gradients in the Ozark aquifer are much lower here than to the east. As the western margin of the gradients become much lower, the groundwater velocities also decrease. It appears that in the vicinity of the freshwater-salinewater transition zone, gradients and flow rates are at their lowest.

The Ozark aquifer is used for municipal, industrial, and agricultural water supply throughout the Springfield Plateau. The aquifer receives recharge in two ways. Regionally, downward movement of water from the Springfield Plateau aquifer, through the Ozark confining unit, and into the Ozark aquifer provides a large volume of recharge. In

addition, there is groundwater recharge by lateral movement of water from the Ozark aquifer outcrop area in the Salem Plateau. The downward movement of water through the Ozark confining unit is controlled by three factors: the thickness of the Northview Formation and other units comprising the Ozark confining unit, the hydraulic conductivity of the Ozark confining unit and the difference in water levels between the Springfield Plateau aquifer and Ozark aquifer. Recharge is probably greatest where the confining unit is the thinnest and where the potentiometric surface of the Ozark aquifer is considerably lower than that of the Springfield Plateau aquifer. Downward flow gradients exist across the Ozark confining unit throughout much of southwest Missouri, especially in areas such as Springfield where extensive pumping of the Ozark aquifer has lowered the potentiometric surface of the Ozark aqufier to well below that of the Springfield Plateau aquifer. However, in some areas, particularly along the valleys of major rivers away from pumping centers, the potentiometric surface of the Ozark aquifer is above that of the Springfield Plateau aquifer, and an upward flow gradient exists.

If large volumes of groundwater are pumped in areas with little or no recharge, the results would be similar to what has occurred in the Ogallala aquifer in Texas, Oklahoma, and Kansas, and in the Dakota Sandstone aquifer in South Dakota. In those areas, groundwater recharge rates are very low, and the water is essentially being mined. Such is not the case in the Springfield Plateau. Granted, there are places where there has been significant groundwater-level decline in the Ozark aquifer, but it has occurred because groundwater production has locally exceeded recharge. In most areas of the Springfield Plateau, water levels in the Ozark aquifer have not changed more than a few feet in the past 50 years.

Agricultural irrigation has been widely used for the past 25 years in Barton, Vernon, Dade, and Cedar counties. There has been a gradual lowering of water levels in the Ozark aquifer, but surprisingly little when compared to the volume of water produced. Groundwater levels in irrigation areas decline several feet during the irrigation season. After the irrigation season is over, groundwater levels recover somewhat, but not quite to the previous pre-irrigation level. Thus, there has been a cumulative drawdown effect; the levels at the end of the successive irrigation seasons are a little lower than the previous year (figure 36). Historically, irrigation in southwestern Missouri has been primarily supplemental in nature. It would seem that if irrigation was used only to supplement seasonal rainfall, significant water level recovery would occur if several abnormally wet years were to occur. Pumpage of irrigation water would be minimal, and recharge could occur unimpeded. However, supplemental irrigation is used nearly every year because even during wet years, July and August precipitation is typically below optimal conditions, and there is a crop-yield loss unless supplemental water is applied. Furthermore, new crops, such as cucumbers, have been introduced in this area and require considerably more water than corn and soybeans.

For many years, there has been a slow, steady decline of the Ozark aquifer potentiometric surface in southwestern Missouri from about McDonald County to Jasper County. Since 1962, groundwater levels have been monitored in this area using an abandoned municipal well at Noel in McDonald County, near the southwest corner of the state. The well is 850 ft deep and is open to the Cotter and Jefferson City dolomites and the Roubidoux Formation. It contains 99 ft of casing, and is cased through the Chattanooga Shale. When this well was drilled in 1931 for the Noel Water Company, it was a flowing artesian well that discharged about 60 gpm without pumping. Static water level of the well was several feet above land surface. Water level in the well decreased to the point that it ceased flowing in the late 1950s. In May of 1962 when it was converted into an observation well, depth to water in the well was 48.7 ft. Today, water level in the well averages about 270 ft below land surface (figure 37).

Much of the water-level decline is thought to be due to municipal well pumpage at Miami, Oklahoma, about 24 miles northwest of Noel. However, during the past two decades there has been considerable groundwater use a few miles south of Noel at large retirement developments in northern Arkansas, as well as from large poultry operations in the McDonald County area.

Estimates indicate that the Ozark aquifer is the most significant aquifer in the Springfield Plateau groundwater province. It contains an estimated 112.6 trillion gallons, or about 346 million acre-ft of usable water.

Ozark Confining Unit

Between the top of the Ozark aquifer and the base of the Springfield Plateau aquifer is a series of low-permeability formations that greatly restrict the vertical interchange of water between the two aquifers. These consist in ascending order of the Chattanooga Shale, the Compton Limestone, the Sedalia Formation, the Northview Formation, and locally the Pierson Limestone. Not all of these units are present throughout the Springfield Plateau, but in most places there is an adequate thickness of them to limit vertical groundwater movement.

The Chattanooga Shale is thickest in the extreme southwestern corner of the state, particularly in McDonald County. It is a very effective aquitard here, but also can cause water quality problems in wells that penetrate it. The Chattanooga is an organic-rich shale. Water having been in contact with it typically contains increased sulfate, may have appreciable concentrations of hydrogen sulfide,

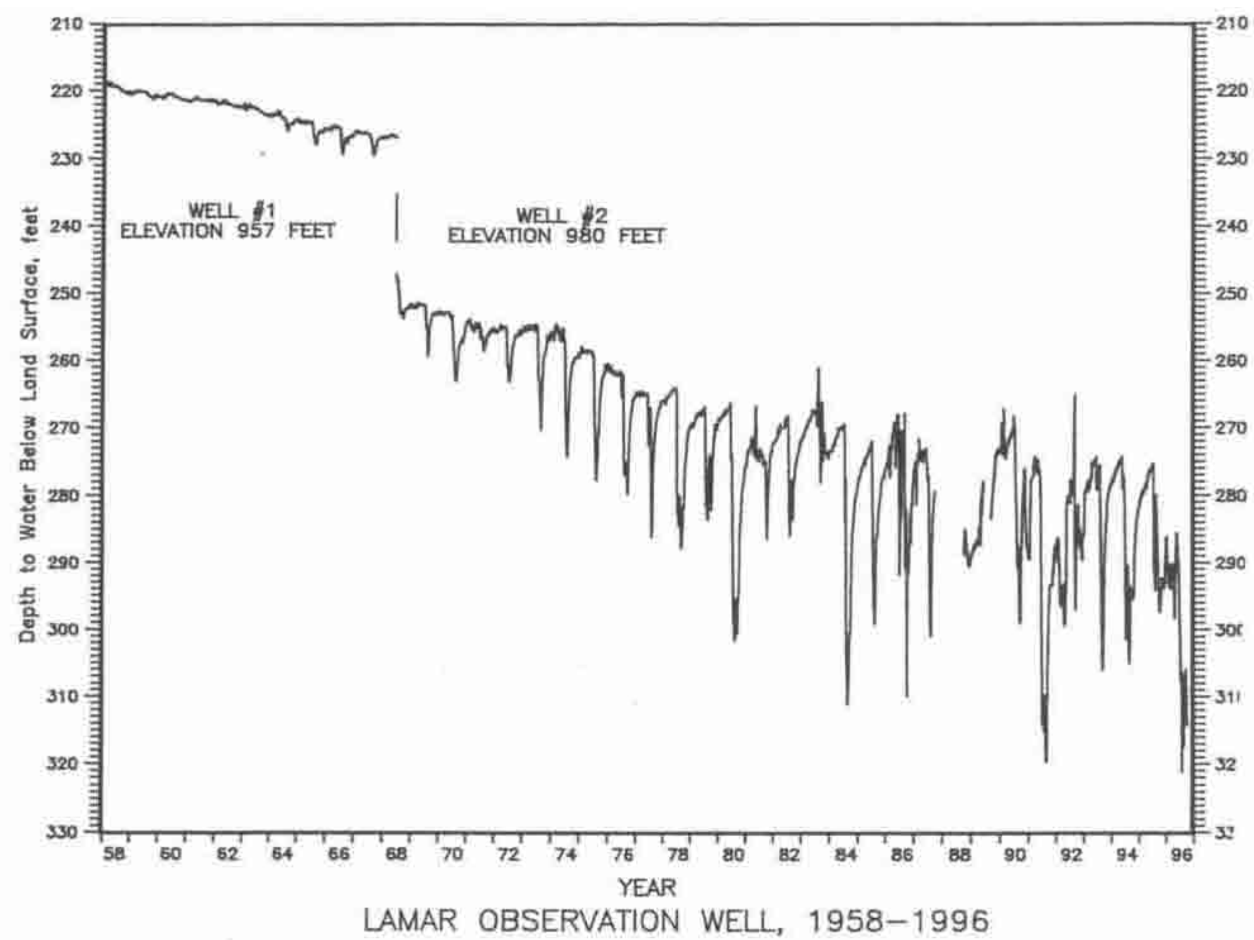


Figure 36. Groundwater-level hydrograph, Lamar observation well, Barton County.

and have an oily, disagreeable taste. Wells that penetrate the Chattanooga should be cased at least several feet below it and be adequately sealed to help prevent these types of water-quality problems.

The Compton Limestone, Sedalia Formation, and Northview Formation all have very low vertical permeabilities, which greatly restricts the vertical movement of water through them. They are, however, not considered to be aquicludes. Aquicludes are water-saturated geologic units that do not transmit significant quantities of water under ordinary hydraulic gradients (Freeze and Cherry, 1979). They are considered aquitards; their permeabilities are too low for the units to yield significant water to wells, but regionally they allow considerable water movement through them. Over a very large geographic area, this will allow significant recharge of the Ozark aquifer to occur.

The vertical hydraulic conductivity of the Ozark confining unit has been estimated by several workers using a variety of methods, but has not been directly measured in most areas. Most of the data are from the Springfield area, where several regional groundwater studies have been conducted in the past 20 years. Emmett and others (1978) estimated the vertical hydraulic conductivity of the Northview Formation in the Springfield area to be about 1×10^{-9} ft/sec. Imes (1989) estimated the vertical hydraulic conductivity using a regional groundwater-flow model of the Ozark Plateau. A hydraulic conductivity of from 1×10^{-8} ft/sec to about 5×10^{-8} ft/sec was calculated. In either case, the hydraulic conductivity of the Ozark confining unit is several orders of

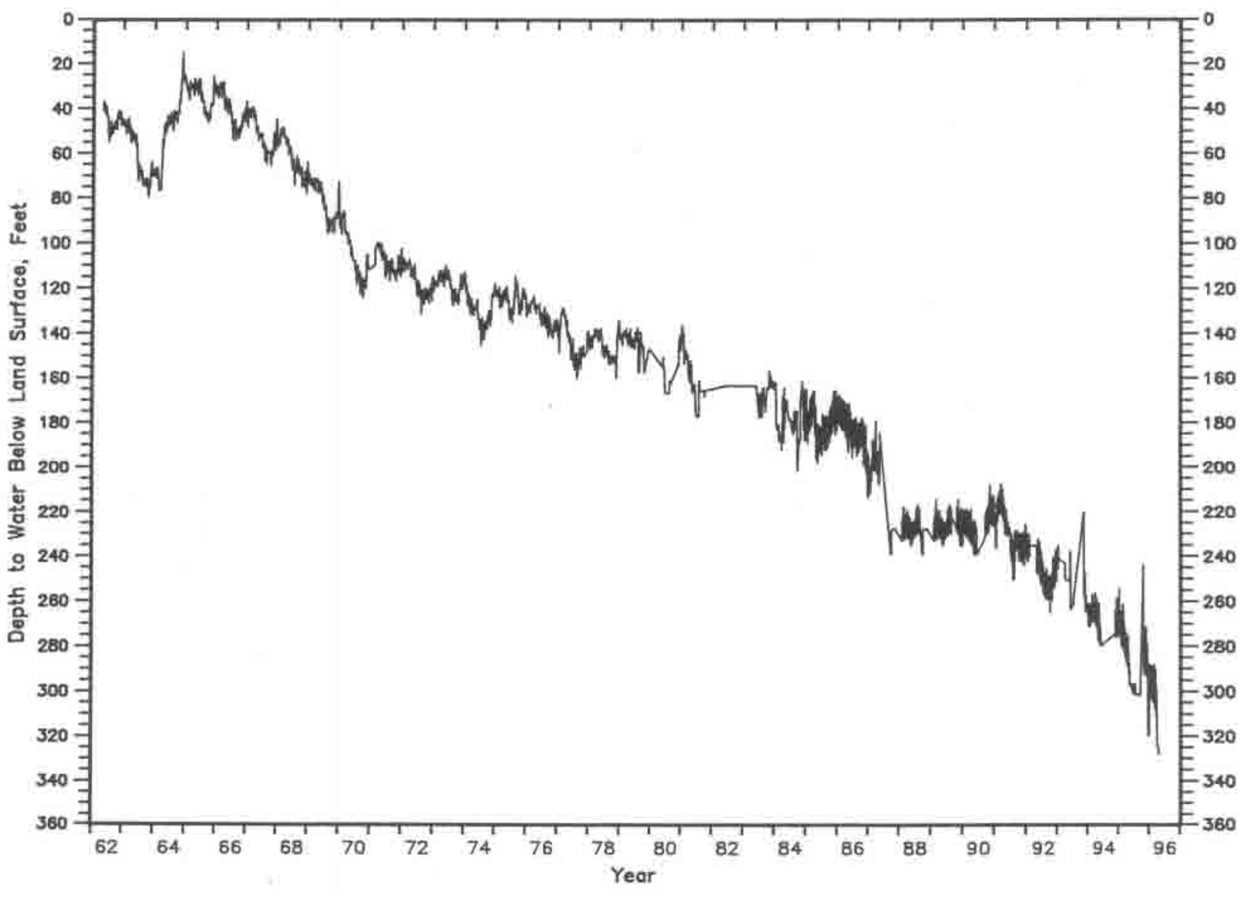


Figure 37. Groundwater-level hydrograph, Noel observation well, McDonald County.

magnitude less than the aquifer units above and below it.

There are numerous faults and other structural features in the Springfield Plateau. Several of the fault systems are known to have a significant affect on aquifer characteristics and groundwater conditions. The permeability produced by faulting varies with location. In places, deep circulation of groundwater in association with faulting can produce large conduit-type openings, and large volumes of residual mud. If water chemistry allows, calcium carbonate may be deposited in the open space. Deposition of this type may completely fill or “heal” the secondary porosity openings produced by faulting, and may form a barrier to groundwater flow. In some instances, a groundwater barrier along the strike of a fault produces a situation where groundwater levels are greatly different from one side of the fault to the other.

In the Chesapeake area of Lawrence County, several Ozark aquifer wells are used to help supply a large Missouri Department of Conservation fish hatchery. The site is bisected by the northwest-trending Chesapeake fault, which is probably the longest and most prominent structural feature in the Springfield Plateau. Water levels, yield characteristics, and water turbidity differs between wells that are only a short distance apart but on opposite sides of the fault.

In some areas, studies have revealed that there is a direct connection between the Springfield Plateau aquifer and the Ozark aquifer. A few miles south of Cassville in Barry County is a large, gently rolling area called the Washburn prairie. The area is underlain by Burlington-Keokuk Limestone, and much of the gently rolling topography is due to large sinkholes developed in the limestone bedrock. Fluorescent dye injected into a sinkhole in this area on April 14, 1993, reappeared between two and eight days later at Roaring River Spring, 6.25 miles to the southeast (figure 38). Roaring River Spring discharges from solution-enlarged openings developed in the Jefferson City and Cotter dolomites. Divers have been able to decend more than 100 ft in the conduit system feeding the spring (Vineyard and Feder, 1982). The elevation of the rise pool at Roaring River Spring is more than 400 ft below the elevation of the bottom of the sinkhole where the dye was injected. To reappear at Roaring River Spring, the dye had to travel horizontally at least 6.25 miles, and move vertically through more than 400 ft of rock, including the zone forming the Ozark confining unit, all in a period of less than eight days. At this location, the Ozark confining unit does not appear to be a significant deterant to communication of water between the Springfield Plateau and Ozark aquifers. Water analyes of Roaring River Spring show that the water has a calcium/magnesium ratio that is considerably higher than expected from a spring discharging from a dolomite aquifer, further evidence that a significant part of the spring's recharge is water that has passed through the Mississippian-age limestones.

This can also be seen at Marvel Cave, located at Silver Dollar City near Branson. The only natural entrance to the cave is a sinkhole developed in the Mississippian-age Reeds Spring Formation. Visitors decend several flights of stairs in the large entrance room before reaching the floor, and the trail from the stairs also continues to lead downward. From the entrance to the low point of the entrance room is a vertical distance of about 180 ft. In the entrance room, the visitor passes through the Reeds Spring Formation, Pierson Limestone, Northview Formation, Compton Limestone, and finally into the Cotter Dolomite. The total vertical extent of the cave is about 380 ft, and it bottoms in the Cotter Dolomite.

SPRINGFIELD PLATEAU AQUIFER

The Springfield Plateau aquifer consists of a sequence of cherty limestones of Mississippian age. Depending on location, the aquifer includes the Elsey Formation, Reeds Spring Formation, Grand Falls Chert, Burlington-Keokuk Limestone, and Warsaw Formation. The Pierson Limestone is considered by some to belong to the Ozark confining unit. However, small amounts of water are available from the Pierson (Imes, 1990b), and

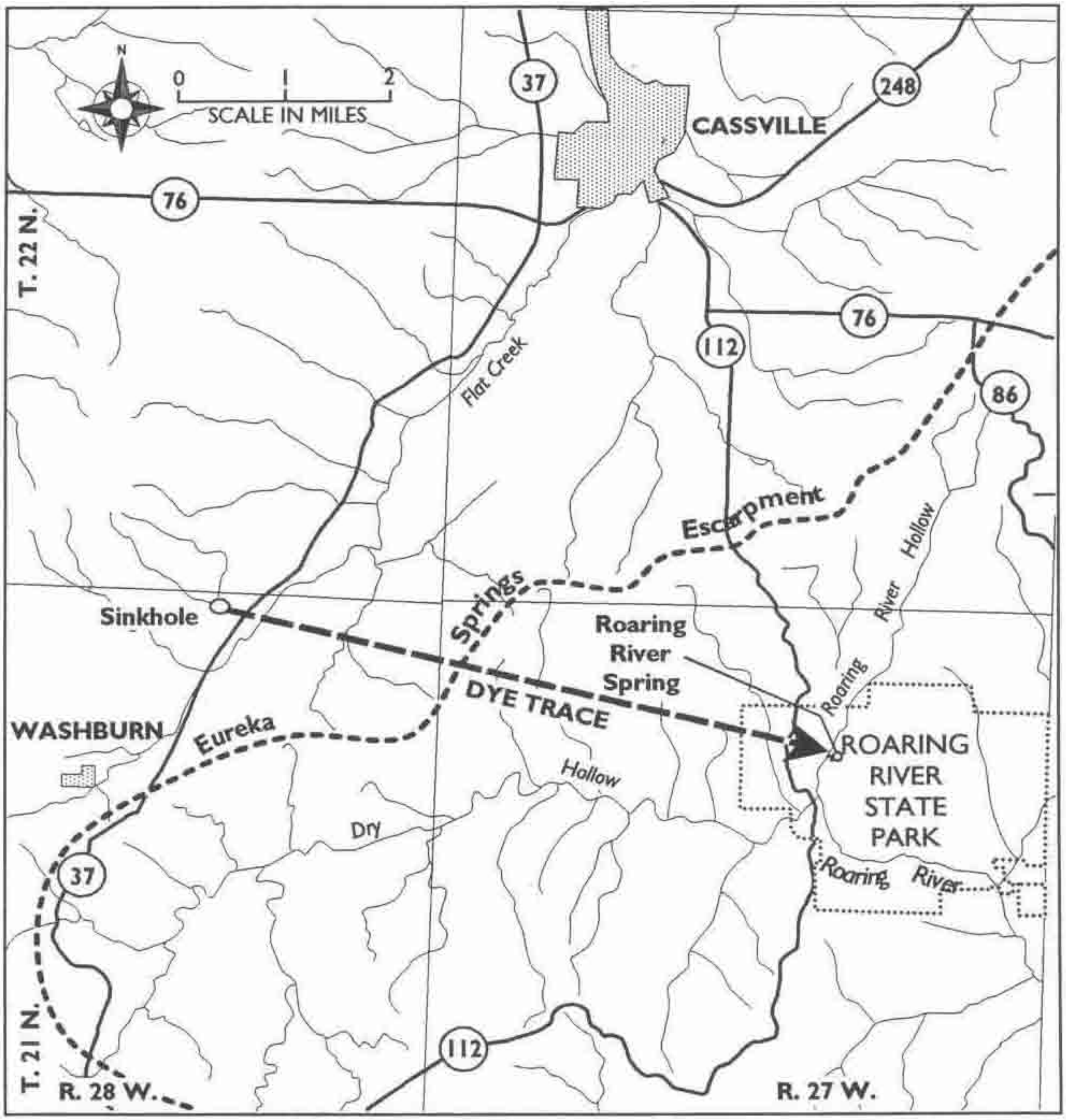


Figure 38. Dye trace from Washburn Prairie to Roaring River Spring, Barry County.

so in this report it will be included with the Springfield Plateau aquifer. Thickness of the aquifer varies from a feather edge at the eastern margin of the Springfield Plateau to more than 400 ft.

All of the Mississippian formations have the potential to yield water in small quantities to private domestic wells in this province. The high chert contents of the Reeds Spring and the lower part of the Burlington-Keokuk exhibit fracture permeability that transmits water freely, and the relatively chert-free limestone sequences in the Burlington-Keokuk have well developed solution-enlarged karst features that can also rapidly transmit large volumes of water. However, even combined, these units will not typically yield more than 30 gpm, and generally less than 15 gpm.

Like the Ozark aquifer in the Salem Plateau, the Springfield Plateau aquifer in southwestern Missouri is unconfined throughout most of the region, and is recharged primarily by precipitation in the outcrop area. Diffuse recharge moving through residual materials probably adds more water to storage than does discrete recharge from losing streams or through sinkholes. Recharge in the western part of the Springfield Plateau province is greatly restricted by the overlying low-permeability Pennsylvanian deposits. Most recharge, which does take place here, is probably the result of horizontal flow of groundwater from the Mississippian rock outcrop area to the east where the Pennsylvanian strata are absent.

The chemical quality of water from the Springfield Plateau aquifer is generally good throughout the province. The water is normally a moderately-mineralized calcium-bicarbonate type. However, since the shallow aquifer is unconfined and there is widespread karst development in the region, there have been numerous instances of groundwater contamination that have affected both wells and springs.

At the western edge of the province, in the vicinity of the freshwater-salinewater transition zone, total dissolved solids increase, and locally there are elevated levels of hydrogen sulfide gas. Associated with the H_2S gas there is locally elevated levels of radionuclides. The direction of groundwater movement in the Springfield Plateau aquifer is generally westerly. However, topography and karst development have a profound influence over flow directions in that part of the aquifer that is less than 200 ft below land surface. Groundwater gradients in the Springfield Plateau aquifer appear to be relatively steep, particularly in those areas with more surface relief. Travel times for water from recharge to discharge point are relatively fast, especially in karst areas.

The karst development in the shallow limestone units, particularly in the Burlington-Keokuk, allows rapid discrete groundwater recharge following precipitation. Karst features are present in most of the Springfield Plateau, but are most prominent in Greene and northern Christian counties where there are numerous caves, sinkholes, losing streams and springs. Unlike the Salem Plateau, where caves are mostly abandoned groundwater pathways, in the Springfield Plateau the caves are often active groundwater conduits, and in some cases it is possible to follow an entire karst groundwater system from sinkhole through cave to spring outlet. This is nearly the case with Smalley Sinkhole Cave and Fantastic Caverns just north of Springfield in Greene County. Smalley Sinkhole Cave is entered through a large, open sinkhole in the base of a normally dry valley. The cave can be traversed for a considerable distance toward Fantastic Caverns, but the two have only been connected using fluorescent dyes. The water exits Fantastic Caverns at a spring overlooking the Sac River, a short distance upstream from the cave entrance. Except for a short distance between the two caves and between the downstream limit of human exploration and the spring in Fantastic Caverns, this system is traversable from recharge point to discharge point.

The rapid movement of water from surface recharge sources has presented water quality problems in part of the Springfield Plateau, particularly near Springfield. During the latter part of the nineteenth century and up

to the mid-l950s, the Springfield Plateau aquifer was an important source of domestic water for rural residents. Although always vulnerable to contamination due to its open nature, as urbanization increased in the Springfield area this sequence of rock became increasingly impacted by man's activities. Many shallow wells in the area became contaminated with not only bacteria, but also gasoline, industrial chemicals and, in some cases, raw sewage.

As early as the 1950s, residents constructing wells were advised to drill and case them deeper to help prevent them from being contaminated. However, there were no well construction regulations that mandated this until the Missouri Well Drillers Act was passed in l985. Regulations approved in 1987 established a sensitive area that includes most of Greene and the northern part of Christian counties. Private domestic wells within this area must be constructed to much more stringent standards than wells in other, less populated areas. Essentially, regulations require that the wells be cased and grouted through the Ozark confining unit, and produce from the Ozark aquifer. As a result of this, the incidence of private well contamination has been reduced greatly in the Springfield area, even though rural population density continues to increase.

Although not as prolific as the St. Francois and Ozark aquifers in this region, the Springfield Plateau aquifer still contains an impressive volume of groundwater in storage, an estimated 5.7 trillion gallons, or about 17.6 million acre-ft. Even though it is less than the deeper, higher-yielding aquifers, its shallow depth and ease of availability will continue to make it a widely used source for private domestic and farm water supply.

WESTERN INTERIOR PLAINS CONFINING SYSTEM

At the western margin of the Springfield Plateau, the Springfield Plateau aquifer is confined on top by the Western Interior Plains confining system. In Missouri, this confining system consists of numerous Pennsylvanian-age formations consisting of relatively thin shale, limestone and sandstone units and several coal beds. Thickness of the Pennsylvanian strata in the Springfield Plateau varies from zero to more than 200 ft.

The vertical and horizontal permeabilities of Pennsylvanian rocks in the province are very low, and this sequence of rock is essentially a very effective aquitard. Recharge from precipitation to the underlying Mississippian-age rocks through the Pennsylvanian is very low. The low permeability of the Pennsylvanian units is reflected by the flow characteristics of certain streams in southwestern Missouri. Streams flowing across the Pennsylvanian-age strata and then across Mississippian-age strata in southeastern Barton and northwestern Jasper counties do not gain flow while flowing on the Pennsylvanian rocks because the units have too low of permeabilities to yield appreciable groundwater. However, when the streams flow across the Mississippian rocks there is an immediate increase in flow, which shows groundwater discharging from the Springfield Plateau aquifer into the streams. Also, groundwater-level observation wells in the western margin of the Springfield Plateau that are cased through the Pennsylvanian strata and open to the Springfield Plateau aquifer show little or no response to local precipitation.

Although the Pennsylvanian rock is not considered an aquifer in the practical sense, shallow wells may encounter small amounts of groundwater in the Pennsylvanian. Yields are generally less than 5 gpm, and the water quality is typically poor due to excessive sulfate, total dissolved solids and iron.

GROUNDWATER CONTAMINATION POTENTIAL

The Springfield Plateau groundwater province has a moderate to high potential or susceptibility for groundwater contamination. Where Mississippian-age limestones directly underlie the surface, especially where karst features allow rapid introduction of water into the subsurface, the Springfield Plateau aquifer is especially vulnerable. However, because shallow- and intermediate-depth groundwater circulation is vertically restricted by

aquitards, the Ozark aquifer is less prone to contamination here than it is in the Salem Plateau groundwater province. Site evaluation guidelines for proposed waste systems and landfills should be kept stringent. It is also evident that large-scale use of pesticides could threaten groundwater quality in this area unless care is taken. The deeper aquifer units are at less risk, but the shallower zones are widely used for domestic water supplies and should be protected.

In the western part of the province where the Mississippian strata are overlain by low-permeability Pennsylvanian-age rocks, there is a very low potential for contamination of the deeper aquifers, and less potential for contamination of the Springfield Plateau aquifer. These areas would require less stringent engineering criteria for waste disposal facilities, and are not as likely to be at affected by man's activities.

Although the Ozark and St. Francois aquifers in the Springfield Plateau are not highly prone to contamination, water-quality degradation can still occur in them. Unplugged abandoned wells that penetrate these aquifers can allow contaminants introduced at the surface to directly enter the deeper aquifer zones. Such an event occurred in the city of Republic in Greene County. The city of Republic well #1 is 1,000 ft deep and contains 300 ft of pressure-grouted casing set through the Northview Formation. The well is open to the Jefferson City and Cotter dolomites, Roubidoux Formation, and the upper half of the Gasconade Dolomite. In 1982, sampling of this well under the National Synthetic Organic Chemical Survey revealed the presence of the solvent 1, 1, 2, trichloroethylene (TCE). Subsequent work showed the source of the TCE to be an abandoned circuit board manufacturing facility about 700 ft from the city well. The building housing the circuit board company burned in 1979. Extensive TCE contamination was found in the soils surrounding the building foundation. Excavation revealed a 540-ft deep abandoned well in the basement of the destroyed building. The well contained only 14 ft of casing, and samples showed water from it contained from 44,000 to 68,000 ug/L of TCE. The abandoned well allowed TCE to enter both the Springfield Plateau and Ozark aquifers as well as a fracture zone in the shallow limestone bedrock. Pumping city well #1 caused the contaminant plume to migrate the 700 ft distance between the city well and the contaminated abandoned well (figure 39).

A remediation project underway at the Republic site will eventually remove most of the TCE from the aquifers. However, the remediation could take more than 20 years, and will cost several million dollars. Obviously, the proper abandonment of any unused well should be a priority for any landowner. Proper well abandonment is required by law. Also, it is far less expensive to plug an abandoned well than to remove contaminants introduced into groundwater because of it.

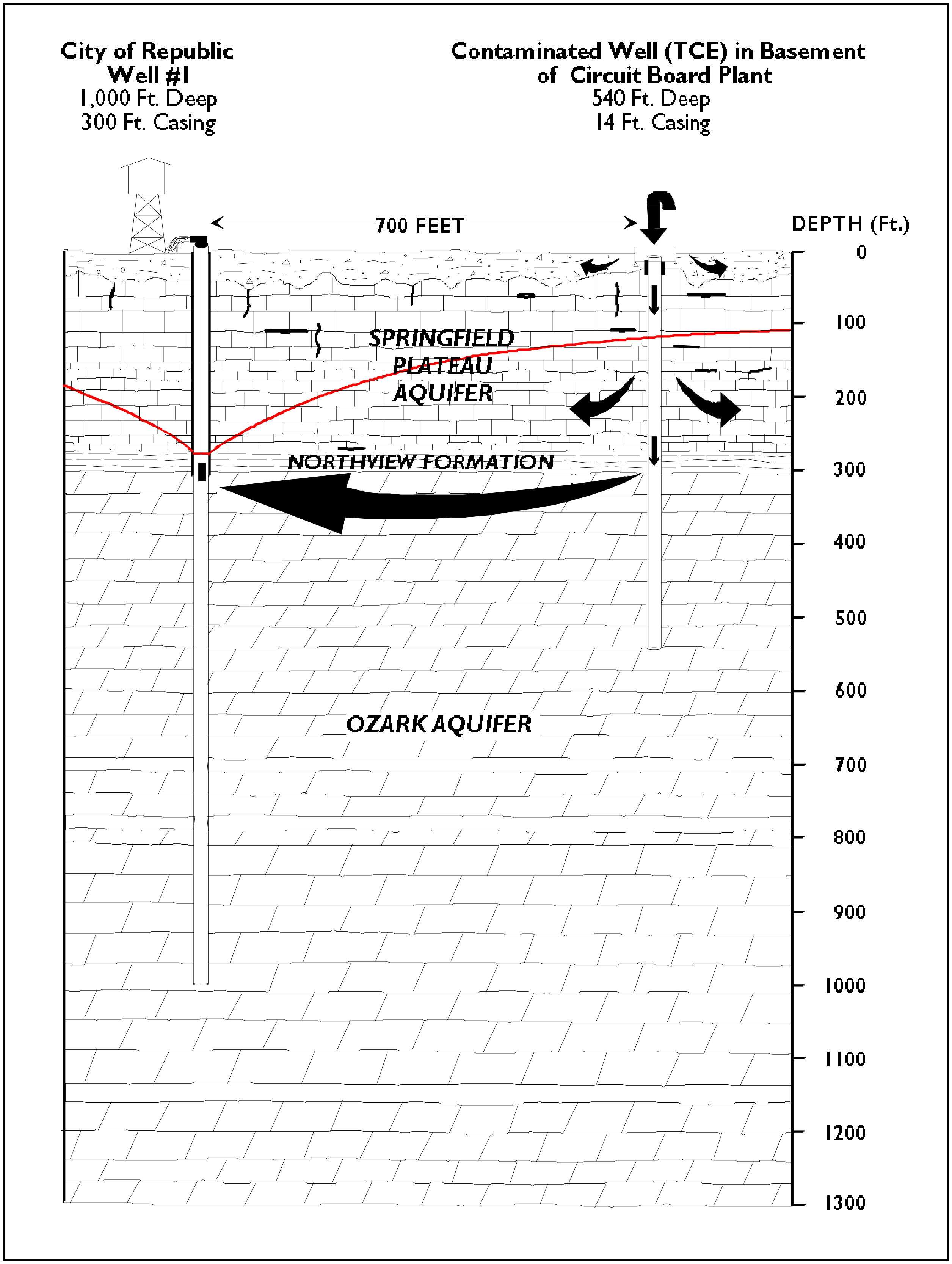


Figure 39. Cross-section at Republic showing contaminant paths and aquifers.

SOUTHEASTERN LOWLANDS GROUNDWATER PROVINCE (BOOTHEEL)

INTRODUCTION

The Bootheel region of Missouri, also known as the Southeastern Lowlands or Mississippi Embayment, is an area of approximately 3,916 square miles located in the extreme southeastern part of the state. This area includes all of Scott, Stoddard, Mississippi, New Madrid, Pemiscot and Dunklin counties, much of Butler County, and small parts of Ripley, Bollinger, Wayne and Cape Girardeau counties (figure 40).

The Southeastern Lowlands is the northern part of a much larger physiographic feature known as the Mississippi Embayment or the Mississippi Alluvial Plain. This feature is essentially contiguous with the Coastal Plain, which stretches across southeastern Texas eastward to include Florida, and northward up the east coast to include Long Island, New York.

Most of the Southeastern Lowlands is a nearly flat, alluvial plain. The fertile alluvial soils, coupled with a warm, moist climate, has helped the Bootheel to become the most productive agricultural region in Missouri. The mostly flat terrain is interrupted by a line of low hills that traverse the region from northeast to southwest, extending from northern Scott County into the northeast corner of Arkansas. This line of dissected hills, including Hickory Ridge, the Benton Hills, and Crowleys Ridge, are erosional or faulted remnants of a once more extensive upland surface that escaped the total destruction of erosion that leveled the rest of the Southeastern Lowland. Although suitable for some agricultural activities, Hickory Ridge, the Benton Hills and Crowleys Ridge are not as well suited for large-scale row-cropping operations such as those found elsewhere in the Bootheel.

When explorers and settlers first arrived in the Southeastern Lowlands, the area was poorly drained and mostly consisted of swampland. There were relatively dry, elevated areas where farming could be practiced, but much of the region was under water or had very wet soil conditions much of the year. Drainage projects began around 1910 to improve surface drainage in the Bootheel. The Southeastern Lowlands had much more water to contend with than that supplied by rainfall. Runoff from sizeable parts of the St. Francois Mountains and Salem Plateau discharged into the Bootheel from the Castor, Whitewater, Black and St. Francis rivers. The Headwaters Diversion Channel was constructed along the northern part of the alluvial plain to route water from the Castor and Whitewater rivers directly into the Mississippi River just south of Cape Girardeau. In the 1940s, two large reservoirs were constructed on the Black (Clearwater Lake) and St. Francis (Wappapello Lake) rivers to control the volume of water entering the lowlands from those drainages. Levees and a series of north-south drainage channels were constructed to drain away excess surface water, lower the water table a few feet, and protect against overbank flooding.

The Southeastern Lowlands is the wettest part of Missouri. Though it receives from about 44 to 47 inches of precipitation during

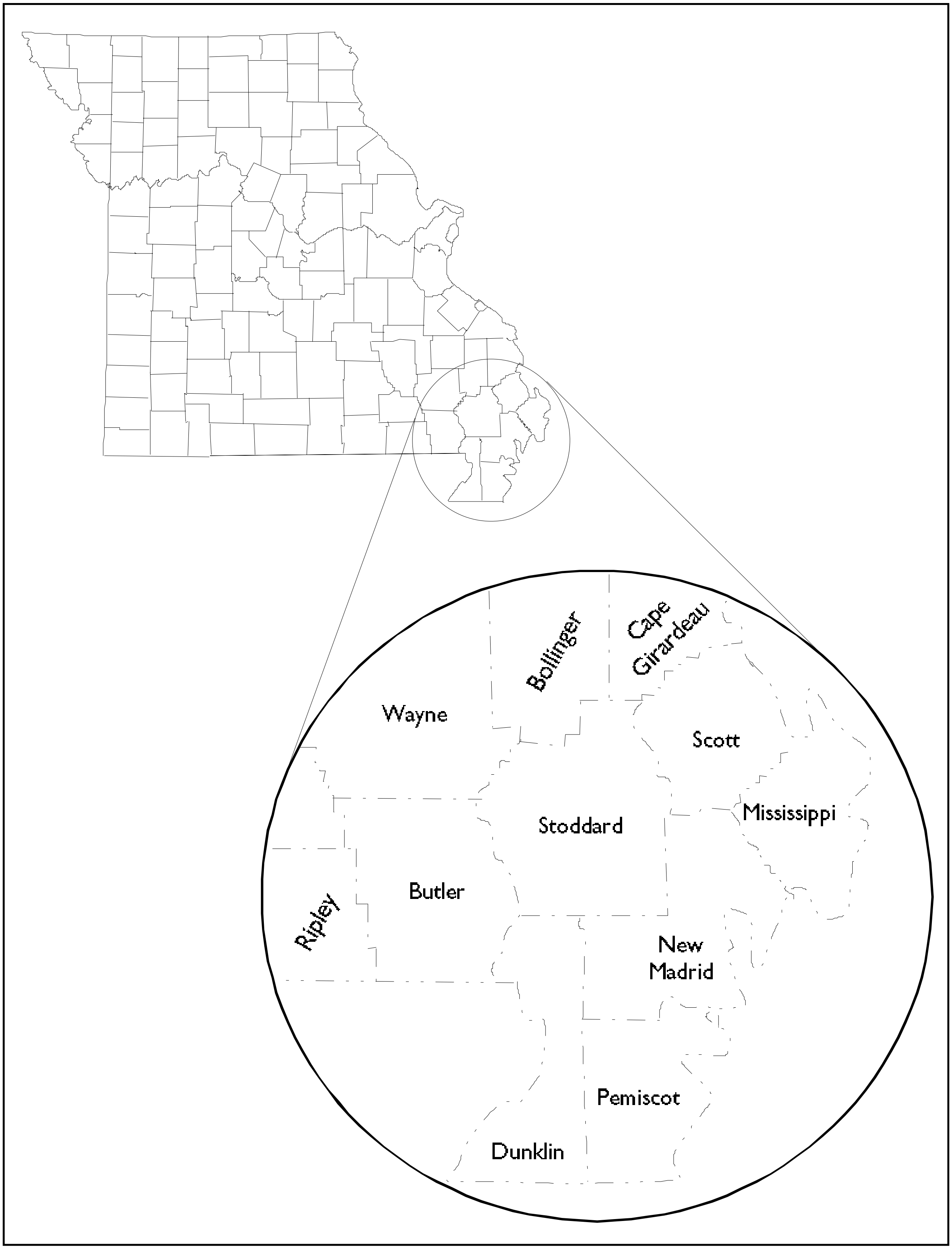


Figure 40. Map of Southeastern Lowlands groundwater province.

an average year, rainfall does not always occur when growing crops need the moisture. Many years ago, farmers discovered that crop production could be greatly enhanced in this area by using supplemental irrigation. The presence of large quantities of both groundwater and surface water became almost as important to the agricultural development of the area as the fertile soils and long growing season. As a result of this fortuitous combination of natural resources, the area has become the most heavily irrigated, and the most productive farmland in the state.

Although the Bootheel occupies only 5.7% of the state, it contains about 15 percent of the usable groundwater. Groundwater storage estimates show that the aquifers underlying the Southeastern Lowlands, combined, contain about 75.7 trillion gallons, or about 232 million acre-ft of water in storage, enough to cover an area the size of the Southeastern Lowlands with about 93 ft of water.

GEOLOGY

The Southeastern Lowlands are part of the larger Mississippi Embayment. The Missouri part of the lowlands is bounded on the north and west by the bedrock formations cropping out along the Ozark Escarpment, on the east by the Mississippi River, and on the south by the Arkansas-Missouri state line. Much of the area is underlain by Quaternary-age alluvial sediments deposited by the ancestral and modern Mississippi and Ohio river systems on top of older Tertiary, Cretaceous, and Paleozoic strata. Figure 41 is a map of the Southeastern Lowlands area showing the physiographic features mentioned above. A generalized stratigraphic description shown in table 12 displays the succession, character, thickness, extent, and hydrology of the sediments. For a more complete description of the geomorphology, and geologic history of the Bootheel, the reader is referred to Luckey (1985).

Much of the change in geologic characteristics between the Salem Plateau and the Southeastern Lowlands is due to geologic structure. The Mississippi Embayment area is considered the most structurally active and complex area in the state. It is beyond the scope of this report to present a detailed description of the structural geology of this area, but some discussion is necessary to understand the present day geologic and hydrologic conditions.

The Mississippi Embayment is an area of extreme structural downwarping. Structural deformation began in the region as long ago as early Paleozoic time, but the northeast-trending structural trough of today began forming about 100 million years ago during the Late Cretaceous period. At that time, the area was underlain by Ordovician-age and older sedimentary rocks. Shallow seas transgressed over the area as the trough was formed and deepened. As subsidence occurred, Cretaceous and later Tertiary marine sediments were deposited in this trough. Depositional environments changed with time and with location. Coarser sediments, such as sands and gravels, were deposited in along the margins of the sea in shallow conditions, while limestones and shales were deposited in deeper parts of the trough. At the end of the Eocene, about 40 million years ago, seas regressed from the area, and it has since remained above sea level (Luckey, 1985).

Structural subsidence along the trough in Missouri is greatest in the extreme southeastern corner of the state. A structural contour map by Grohskopf (1955) shows about 2,900 feet of structural relief between the top of the Paleozoic rocks in southeastern Pemiscot County to the same horizon along the Ozark Escarpment. Figure 42 is a north-south geologic cross-section through the Southeastern Lowlands that shows the general dip of the strata.

Cretaceous and Tertiary sediments deposited in the Bootheel are thickest in the deeper parts of the trough, and thin toward the margins of the embayment.

Paleozoic Strata (undifferentiated)

A distinction has been made between the unconsolidated, younger sediments of the Mesozoic and Cenozoic, and the underlying consolidated Paleozoic-age bedrock formations. In the southern and southeastern part of

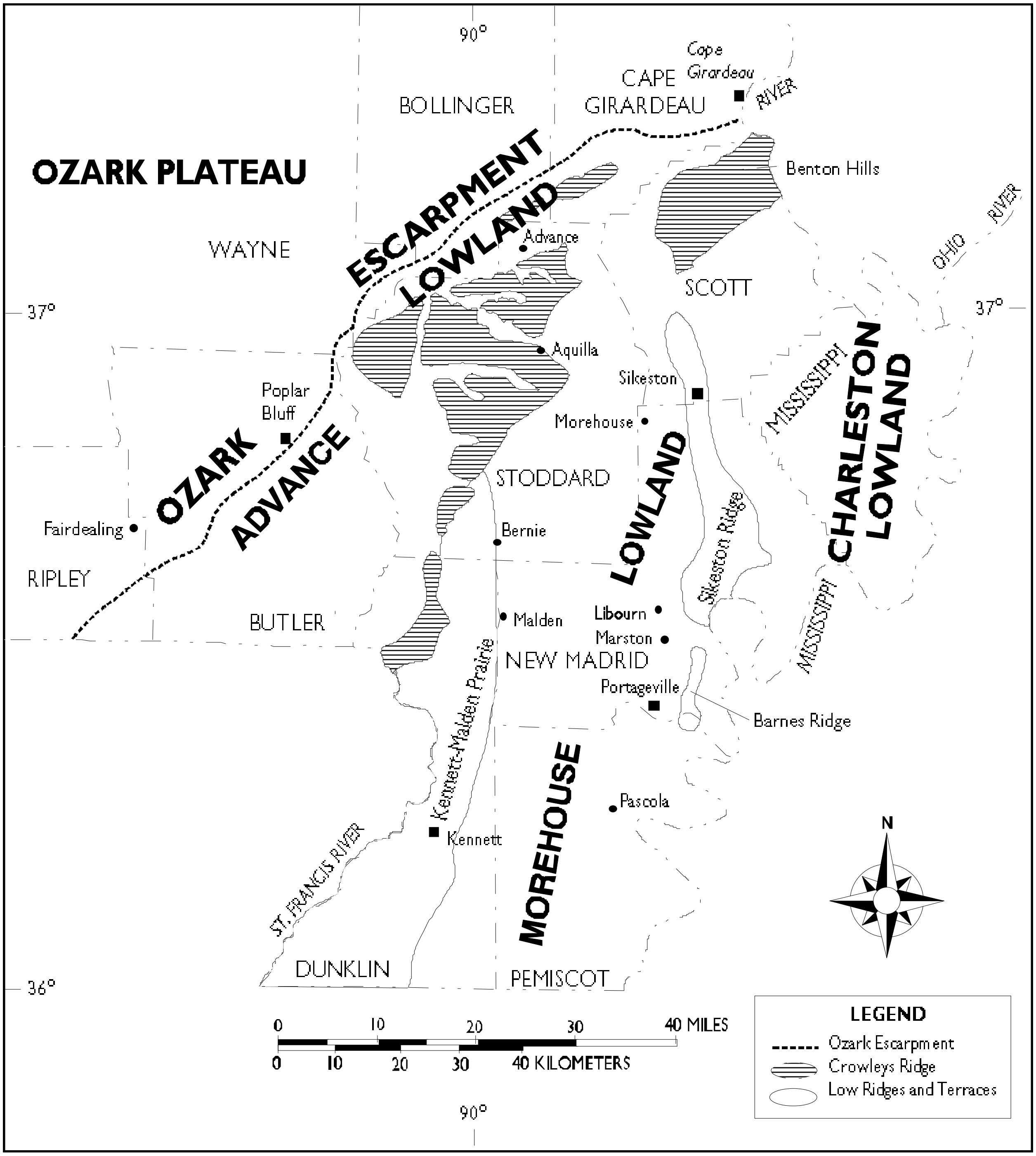


Figure 41. Physiographic map of the Southeastern Lowlands (from Luckey, 1985).

the Bootheel, the bedrock formations are too deeply buried or are not hydrologically significant in terms of yield or water quality to be of interest for this study. The exception to this is the area between Crowleys Ridge and the Ozark Escarpment. The Paleozoic rocks directly underlie the alluvium in much of this area and are considered usable aquifers. South of about Puxico between Crowleys Ridge and the Ozark Escarpment, the Roubidoux Formation underlies the recent alluvial materials and forms the bedrock surface. Between Puxico and Delta, Jefferson City and Cotter dolomites underlie the alluvium. From Delta to the Missis-

Era	System	Group	Formation	Maximum thickness expected (feet)	Extent	Lithologic character	Hydrologic character
Cenozoic	Quaternary		Alluvium	250	Underlies entire lowland area except Crowleys Ridge	Gravel, sand, silt, & clay.	Chief aquifer in the area. May yield 3,000 gpm to wells in some localities.
			Loess	35	Covers Crowleys Ridge, Benton Hills, & uplands.	Tan to brown silt. May contain some clay.	Occurs above the water table.
	Tertiary		Terrace Gravel	60		Gravel, cobbles, some clay.	
		Wilcox		1,400	Crops out on Crowleys Ridge & Benton Hills. Underlies all of area south and east of line from Campbell to Charter Oak to Sikeston to Lusk.	Sand, some clay. Contains thin beds of lignite.	A major aquifer used chiefly for municipal supply. Known to yield 1,500 gpm in favorable localities. May contain at least two aquifers with separate potentiometric surface.
		Midway	Porters Creek Clay	650	Crops out on Crowleys Ridge & Benton Hills. Underlies all of area south and east of line from Neelyville to Bloomfield to Commerce.	Clay, light gray when dry, but dark gray when wet.	Does not yield significant quantities of water to wells. Acts as barriers to groundwater movement.
			Clayton Formation	30		Calcareous, glauconitic sand and clay to fossiliferous limestone.	
Mesozoic	Cretaceous		Owl Creek Formation	100	Crops out on Crowleys Ridge and Benton Hills. Underlies entire area except within about ten miles of Ozarks.	Bluish-gray to brown sandy clay.	Generally impedes the flow of groundwater.
			McNairy Formation (Ripley Sand)	600 (combined thickness)		Sand, sandy clay, and clay. Nonmarine at outcrop, but marine in deep part of the embayment.	A significant aquifer widely used for municipal supplies. High heads make this aquifer attractive but excessive mineralization and high temperatures limit its use in some areas.
			Pre-McNairy Cretaceous Beds		Present only in deeper parts of the embayment	Sand, chalk, marl, clay, and limestone.	
Paleozoic				>2,680	Crops out on Crowleys Ridge, Hickory Ridge, & Benton Hills. Underlies entire area.	Limestone, sandstone, and dolomite	Used for municipal supplies close to the Ozarks. Would probably yield large amounts of water in other areas but this water may be highly mineralized in some areas.

(The stratigraphic nomenclature used in this report is that of the Missouri Division of Geology and Land Survey)

Table 12. Generalized stratigraphic section of sediments in the Southeastern Lowlands groundwater province (modified from Luckey, 1985).

sippi River, younger Ordovician rock, including the Kimmswick and Dutchtown formations, underlie the alluvium. The hydrologic characteristics of the shallow Paleozoic units between the Ozark Escarpment and Crowleys Ridge are much the same as immediately to the northwest in the Salem Plateau. East of Crowleys Ridge, the Paleozoic units are generally too deep to be considered practical for water supply, and probably contain water that is too highly mineralized to be considered potable.

CRETACEOUS SYSTEM

McNairy Formation

The Cretaceous-age McNairy Formation is the oldest stratigraphic unit that has hydrologic significance in the area southeast of Crowleys Ridge. Pre-McNairy Cretaceous beds

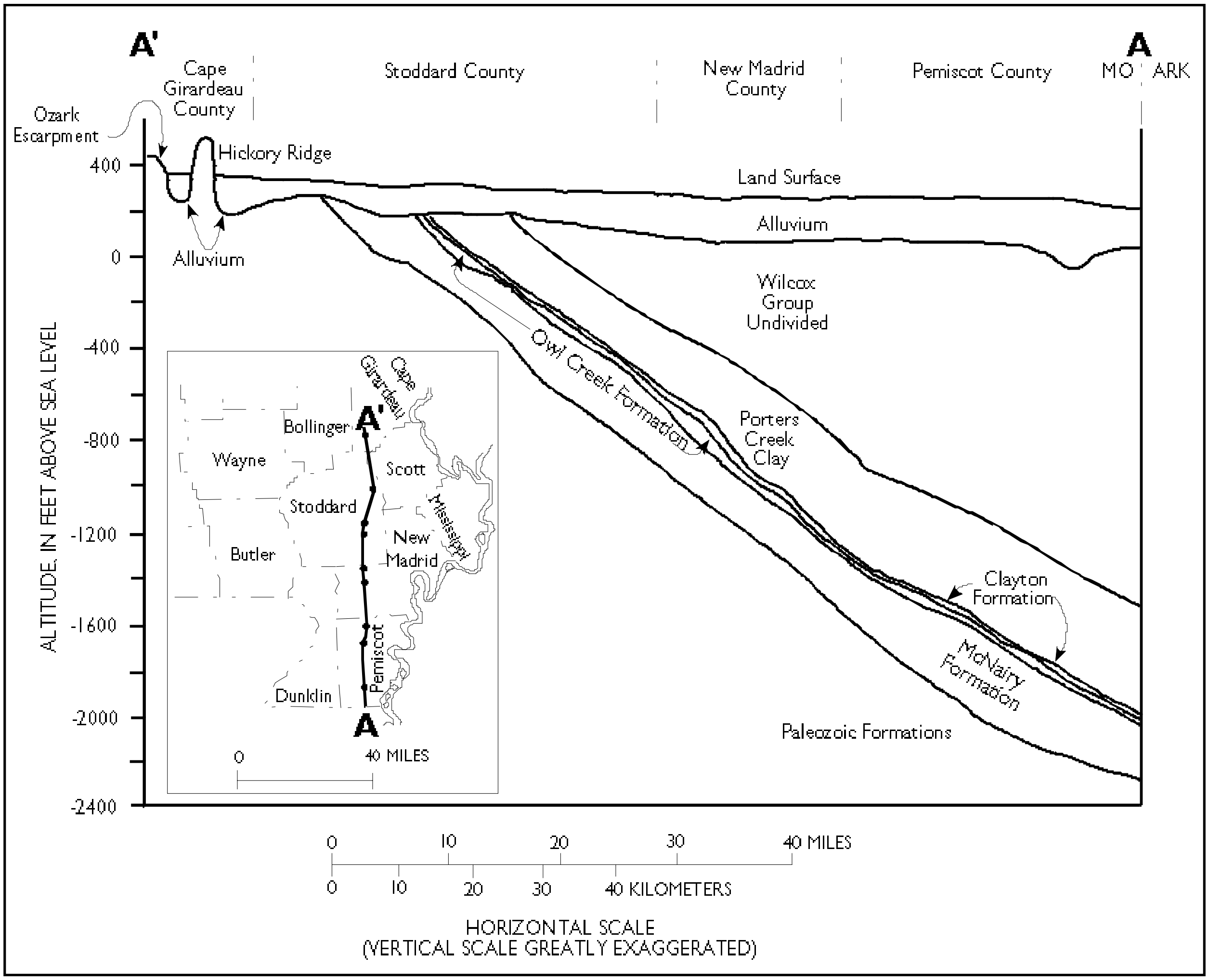


Figure 42. North-south geologic cross-section of the Southeastern Lowlands (modified from Luckey, 1985.)

underlie the McNairy in the deeper parts of the trough. These materials consist of sand, chalk, marl, clay and limestone, and are not considered significant aquifers.

The McNairy crops out on Crowleys Ridge and unconformably overlies the Paleozoic units throughout the area to the east and south. It is present throughout the Southeastern Lowlands except within about 10 miles of the Ozark Escarpment. The McNairy consists of sand, sandy clay and clay, and ranges from less than 100 ft thick in its outcrop area to more than 600 ft thick in the extreme southern part of the Bootheel. The unit is considered nonmarine in the outcrop area, but is a marine deposit through the deeper part of the Embayment (Luckey, 1985).

Owl Creek Formation

The Owl Creek, the youngest Cretaceous-age unit in the area, overlies the McNairy Formation. It consists of up to 100 ft of brown, glauconitic sandy clay where the full thickness of the formation is present, but in some areas much of the Owl Creek was removed by erosion before deposition resumed in the Tertiary.

TERTIARY SYSTEM

Midway Group: Clayton Formation and Porters Creek Clay

Sedimentary rock of the Midway Group overlies the Owl Creek Formation throughout much of the Southeastern Lowlands. The lowermost unit is the Clayton Formation,

which consists of up to about 30 ft of various sediments including calcareous, glauconitic sand and clay, and limestone. The unit is generally more clastic near the boundaries of the Embayment, and more calcareous in the deeper parts of the trough (Grohskopf, 1955). The Clayton is overlain by a much thicker clay unit called the Porters Creek Clay. This unit is up to about 650 ft thick, and consists of dark-gray clay. The Porters Creek is present throughout the Southeastern Lowlands south and east of Crowleys Ridge.

Wilcox Group (undifferentiated)

The Wilcox Group overlies the Porters Creek, and consists of up to about 1,400 ft of sand with some clay and thin beds of lignite. The unit crops out along the southeastern side of Crowleys Ridge and the Benton Hills, and underlies all of the Southeastern Lowlands south and east of a line extending from Campbell to Charter Oak to Sikeston to Lusk (Luckey, 1985). It is thinnest along its outcrop belt, and thickest in the deepest parts of the trough. Quaternary alluvium overlies the Wilcox throughout much of the area.

Terrace Gravels

Up to about 60 ft of terrace gravels overlie the Wilcox in some areas. Where these gravels are not overlain by alluvium, they are easy to distinguish in the subsurface. However, where alluvium overlies them, they are difficult to distinguish from the basal gravels of the alluvium.

QUATERNARY SYSTEM

Alluvium

The youngest stratigraphic unit that has hydrologic significance is the Quaternary-age alluvium. The alluvium overlies older stratigraphic units throughout the entire Southeastern Lowlands except for Crowleys Ridge, Hickory Ridge, Benton Hills, and a few other low ridges where Tertiary-age sands crop out. The alluvium consists mostly of sand and gravel with lesser amounts of clay and silt at the surface. Thickness of the alluvium varies with location. It is generally thinnest west of Crowleys Ridge where it ranges from zero to about 200 ft thick. East of Crowleys Ridge the alluvium is somewhat thicker, and is locally more than 250 ft thick in extreme southern Dunklin and Pemiscot counties and southeastern Mississippi County.

The alluvium was deposited by the actions of the Mississippi and Ohio Rivers, and to a much lesser extent, the actions of the St. Francis, Black, Castor and Whitewater rivers. The actions of these rivers also are responsible for much of the physiographic character of the lowlands. According to Magill (1968), as presented by Luckey (1985), the Mississippi River originally turned southwest just south of Cape Girardeau, and flowed through the area between the Ozark Escarpment and Crowleys Ridge called the Advance Lowlands. At the same time, the Ohio River was following a channel through the southern tip of Illinois, north of its present course, and along the southeast side of Crowleys Ridge. The Ohio, which was probably a few feet lower than the Mississippi, captured the Mississippi through stream piracy and the Mississippi River eroded the gap between Crowleys Ridge and Benton Hills. Later, a similar stream piracy between an Ohio River tributary and the Mississippi river east of Benton Hills moved the confluence of the two rivers upstream to near its present position.

HYDROGEOLOGY

There are several separate and distinct aquifers in the Southeastern Lowlands that have different hydrogeologic characteristics. Two of these consist of Paleozoic consolidated rock units, while the other three are mostly comprised of younger unconsolidated sediments. In ascending order they are the St. Francois aquifer, Ozark aquifer, McNairy (Ripley Sand) aquifer, Wilcox aquifer, and the alluvial aquifer. There are also several confining units that greatly limit the vertical movement of groundwater between the aquifers.

PALEOZOIC BEDROCK AQUIFERS

Paleozoic (Ordovician-age and older) bedrock underlies essentially all of the South-

eastern Lowlands. In some locations between Crowleys Ridge and the Ozark Escarpment, the alluvium is directly underlain by Ordovician bedrock. Most of these units are dolomites with lesser quantities of sandstone. Between Crowleys Ridge and the Ozark Escarpment, the Ozark aquifer is commonly used for private domestic water supply and, to a much lesser extent, for public water supply. Although the alluvium in this area is shallower and has large quantities of water available, it generally contains high levels of dissolved iron that requires treatment before it is usable for some purposes.

Little is known about the St. Francois aquifer in this area. It is thought to contain potable water between the Ozark Escarpment and Crowleys Ridge, but there is little information to substantiate this.

The Paleozoic bedrock aquifers are also present at greater depths throughout the entire Southeastern Lowlands area. However, east and south of Crowleys Ridge the depth to the bedrock becomes excessive, and there is ample water available from numerous shallower aquifer zones so the Paleozoic bedrock aquifers are not used in this area. There is a gradual deterioration in bedrock aquifer water-quality from northwest towards the southeast across the Bootheel. The Ozark aquifer dips or tilts towards the southeast, and as it dips, it also thickens. The further downdip the individual aquifers zones become, the more highly mineralized their water becomes. The relatively meager data currently available for bedrock aquifers in the area south and east of Crowleys Ridge indicates that these zones commonly contain water that is too highly mineralized for most uses. A well drilled to test for the possibility of oil in Mississippi County reached a depth of 4,900 feet, and produced water that contained almost 67,000 mg/L total dissolved solids concentration (Luckey and Fuller, 1980). Water produced from these same zones farther to the north in Scott County is of much better quality, and meets public drinking water standards.

Yields of wells penetrating the Paleozoic bedrock aquifers in the Southeastern Lowlands are similar to those of wells penetrating the same zones in the Salem Plateau area to the northeast; yields vary greatly with location, depth, and zones open to the aquifer. Yields of a few gallons per minute are generally available to private domestic wells penetrating the uppermost part of the bedrock. Deeper wells in favorable locations can yield several hundred gallons per minute.

Data are currently inadequate to fully characterize the hydraulic and water-quality characteristics of the Paleozoic bedrock in the Southeastern Lowlands. Available information indicates that west of the eastern margin of Crowleys Ridge, the Paleozoic bedrock aquifer contains fresh water. This consists of an area of about 1,400 square miles. The estimated volume of usable groundwater in storage in this area in the St. Francois aquifer is 2.59 trillion gallons, or about 7.9 million acre-ft. The Ozark aquifer is estimated to contain about 7.88 trillion gallons, or about 24.2 million acre-ft.

MCNAIRY AQUIFER

The McNairy Formation, locally referred to as the Ripley Sand by many area water well drillers and residents, underlies about 3,328 square miles, or nearly 85 percent of the Southeastern Lowlands. This aquifer is widely used for municipal water mainly because of two factors. First, the McNairy is under considerable artesian head in some of the area, and in places the potentiometric surface is several feet above ground level. The high static water levels in the wells penetrating the McNairy greatly reduce pumping costs. More significantly, away from the outcrop belt along Crowleys Ridge, the McNairy yields very soft water that contains little dissolved calcium, magnesium and iron. Water from the shallower Wilcox Group and the alluvium almost always requires treatment for iron and manganese removal. Water from the McNairy typically does not. The depths of wells producing from the McNairy vary greatly from less than 200 ft in the northern and western parts of the Southeastern Lowlands, to more than 2,000 ft in southern Dunklin and Pemiscot counties.

Yields of wells penetrating the McNairy vary somewhat, but generally range between 150 and 750 gpm. Yields are lowest on and along Crowleys Ridge where the unit is relatively thin, and also in other places where the McNairy may be thick but where clay interbeds greatly decrease the total thickness of clean, permeable sand. Several aquifer tests performed on wells penetrating the McNairy generally show transmissivities ranging from 9,000 to 16,000 gpd/ft (1,200 to 2,140 ft^2/day), and storage coefficients of about 1 x 10^{-4}. Storage coefficients are generally higher, about 1 x 10^{-3}, in the outcrop area of the unit along Crowleys Ridge. The direction of groundwater movement in the McNairy in Missouri appears to be generally to the southeast.

The quality of water from the McNairy varies with location and proximity to recharge sources. The McNairy likely receives recharge from three sources. The most obvious source is precipitation falling on the unit where it crops out on Crowleys Ridge, or where surface stream-flow is directly across it. There is probably considerable recharge to the McNairy from the overlying alluvium west of Crowleys Ridge where the unit is directly overlain by alluvial materials. In both of these areas, water from the McNairy contains less sodium, more iron, calcium and magnesium, and has a higher carbonate hardness than in areas to the south and east. There is probably very little recharge to the McNairy from either the alluvium or Wilcox Group east and south of Crowleys Ridge. The thick Porters Creek Clay has very low hydraulic conductivity, and combined with the Clayton and Owl Creek formations form a very effective aquiclude separating groundwater in the Wilcox Group from that in the McNairy. There is evidence that the McNairy receives some recharge from the deeper Paleozoic bedrock aquifers. Water quality in the McNairy is poorest in a roughly circular area covering eastern Stoddard, southern Scott, southwestern Mississippi, and much of New Madrid counties (figure 43). Here, total dissolved solids and chloride concentrations in the McNairy generally exceed public drinking water standards. The reason for the poor water quality in this area is not entirely clear, but may be due to faulting, which has allowed salinewater from deeper Paleozoic units to move upward into the McNairy (Luckey, 1985).

Although the McNairy underlies an area containing about 3,328 square miles, the area of the aquifer containing water with less than 250 mg/L chloride is about 2,701 square miles. The volume of potable water stored in the Ripley is estimated to be about 12 trillion gallons, or about 37 million acre-ft.

WILCOX AQUIFER

The Wilcox Group is the thickest of the unconsolidated aquifers in the Southeastern Lowlands, ranging from zero along the southeastern side of Crowleys Ridge to more than 1,250 ft in southeastern Pemiscot County. It underlies an area of about 2,346 square miles, or about 60 percent of the Southeastern Lowlands. Although all of the unit is water-saturated, it does not possess uniform water-yielding characteristics. It is mostly sand, but clay and lignite beds in the formation reduce hydraulic conductivity in parts of the unit. Most high-yield wells drilled into the Wilcox target a thick, permeable sand zone near the base of the unit where there are few clay beds. Generally, the lowermost 250 to 400 ft of the formation contains the greatest quantity of clean sand.

Properly constructed wells penetrating the Wilcox Group generally yield from less than 200 gpm where the unit is thin near its outcrop belt, to as much as 1,700 gpm where the unit is much thicker. The quality of water from the Wilcox is less desirable than that of the McNairy. Water from the Wilcox Group is typically a calcium-bicarbonate or calcium-magnesium-bicarbonate type. Total dissolved solids, sulfate and chloride typically meet public drinking water standards. The only constituents that present problems to public water suppliers are iron and manganese. Both of these metals are typically present above public drinking water standards. Iron levels above 0.3 mg/L and manganese levels above 0.05 mg/L can cause staining of laundry and

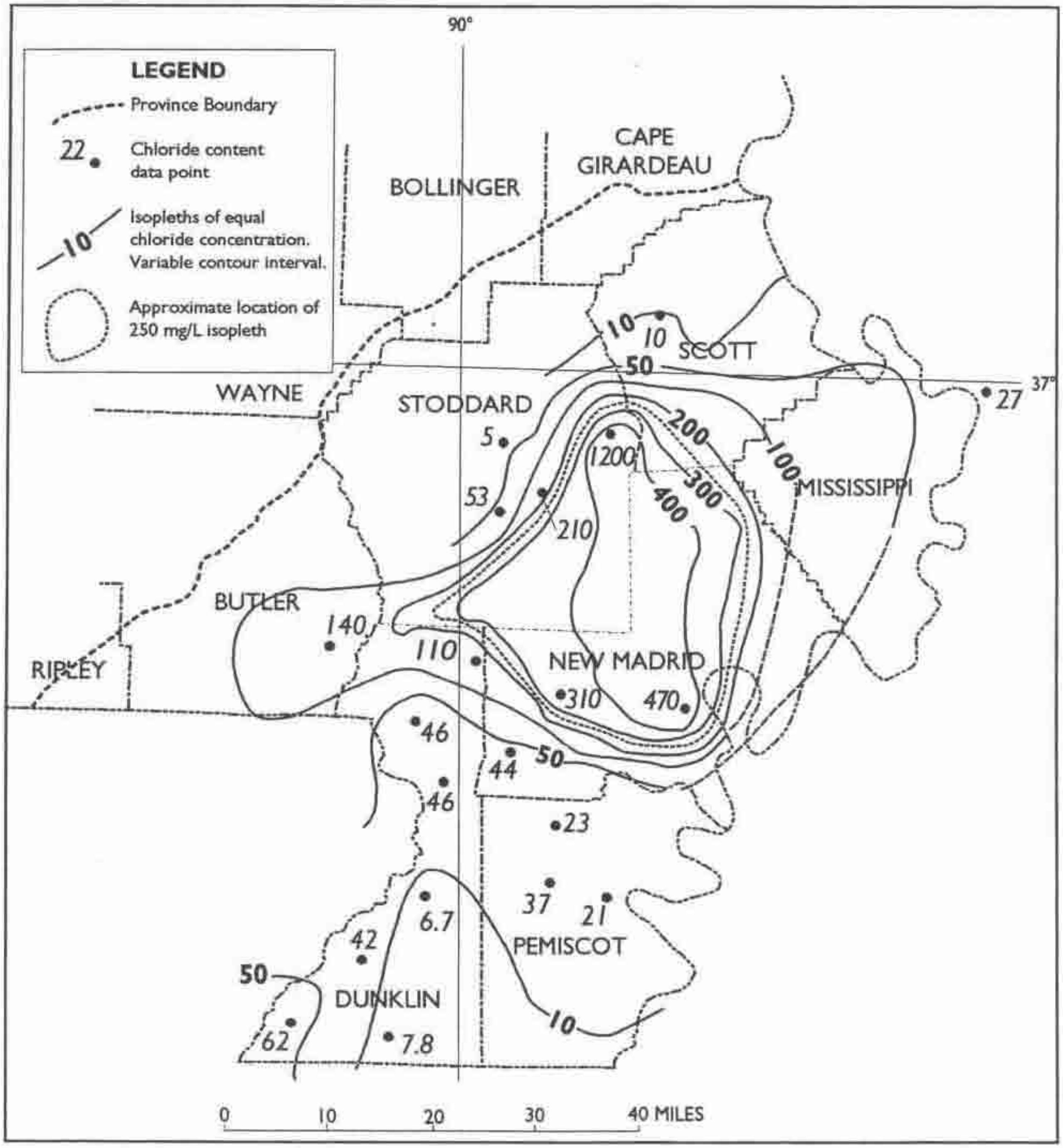


Figure 43. Chloride content in the McNairy aquifer, Southeastern Lowlands (from Brahana and Mesko, 1988).

plumbing fixtures. Water from the Wilcox commonly contains from 0.3 mg/L to about 4 mg/L. Manganese is generally between 0.03 mg/L and 0.3 mg/L. Although these metals are higher than desirable in groundwater from the Wilcox, they are generally much lower than levels found in the shallower alluvium.

The Wilcox aquifer receives recharge from downward movement of water from the overlying alluvium, particularly in the area immediately southeast of Crowleys Ridge where the thicker, more permeable sands of the Wilcox are directly overlain by alluvium. Based on water-level measurements from wells pen-

etrating the lower Wilcox, the direction of groundwater movement in the unit is generally to the south (Luckey, 1985).

The Wilcox likely contains a greater volume of fresh water than any other aquifer in southeastern Missouri. It is estimated to contain about 32 trillion gallons, or about 98 million acre-ft.

Southeast Lowlands Alluvial Aquifer

Without question, the most widely used aquifer in the Southeastern Lowlands is the alluvial aquifer. The alluvium underlies about 92 percent of the Southeastern Lowlands, an area of approximately 3,677 square miles (figure 44). Its thickness ranges from 0 to as much as 300 feet, with the thinner areas adjacent to the Ozark Escarpment along the northwest boundary, and adjacent to Crowleys Ridge and Benton Hills. The alluvium consists of unconsolidated sand, gravel, silt and clay, deposited mostly by the ancestral Mississippi and Ohio river systems (Luckey, 1985). The only places in the Southeastern Lowlands where the alluvium is absent is on Crowleys Ridge, Benton Hills, and other similar positive features that are well above floodplain level.

Groundwater is stored and transmitted in the alluvium through intergranular pore space. The gradient of the water table is generally to the south and quite low, about 1 ft/mi. Water-table elevation in the northern end of the Embayment is about 330 ft msl, while it is about 90 ft lower at the Arkansas border at the southern tip of the Bootheel. West of Crowleys Ridge, groundwater in the alluvium generally moves toward the south, and toward the Black and St. Francis rivers. East of Crowleys Ridge, the overall direction of alluvial groundwater movement is also to the south, but toward either the Little River drainage ditch system, or farther east toward the Mississippi River channel (figure 45).

Yields of wells drilled into the alluvium depend on several factors including the saturated thickness of the alluvium, the diameter of the well and length of well screen, and the hydraulic conductivity of the alluvial materials. Properly constructed high-yield wells penetrating the alluvium rarely yield less than 500 gpm, and can yield as much as 3,000 gpm. Specific capacities typically range from 35 to 150 gpm/ft of drawdown. Aquifer tests of the alluvial aquifer show that it has a very high transmissivity. East and south of Crowleys Ridge, transmissivity values are generally between 240,000 and 400,000 gpd/ft (32,000 and 54,000 ft^2/day). Storage coefficients calculated from short-term tests of about 24 hours or less are generally between 1×10^{-4} and 2×10^{-3}. During longer term pump tests, the storage coefficients would likely increase several orders of magnitude, and would more closely resemble the effective porosity of the alluvial materials less the specific retention.

Aquifer tests performed on alluvial wells west of Crowleys Ridge show that the alluvium in that area is generally less permeable than to the east and south of Crowleys Ridge. Transmissivities in this area can be between about 112,000 gpd/ft and 350,000 gpd/ft (15,000 and 47,000 ft^2/day). Storage coefficients are similar to those east of Crowleys Ridge. The alluvium west of Crowleys Ridge is thought to be more closely associated with the St. Francis, Black and ancestral Mississippi rivers, while that to the east is more closely associated with the Ohio and modern-day Mississippi rivers.

Water levels in the alluvium fluctuate in response to several factors, all related to aquifer recharge or aquifer discharge. The alluvial aquifer receives most of its recharge from precipitation. Recharge is generally greatest where the surficial materials are very sandy and less where they contain a higher percentage of silt or clay. There is also appreciable recharge in the aquifer near the Mississippi River during high river stages. Overall, however, most of the recharge is due to infiltration from precipitation.

Discharge from the alluvial aquifer is both from natural and artificial means. Natural discharge is generally from water movement from the alluvium into the Mississippi, St. Francis and Black rivers, the Little Blue River drainage ditches, and the Headwaters Diver-

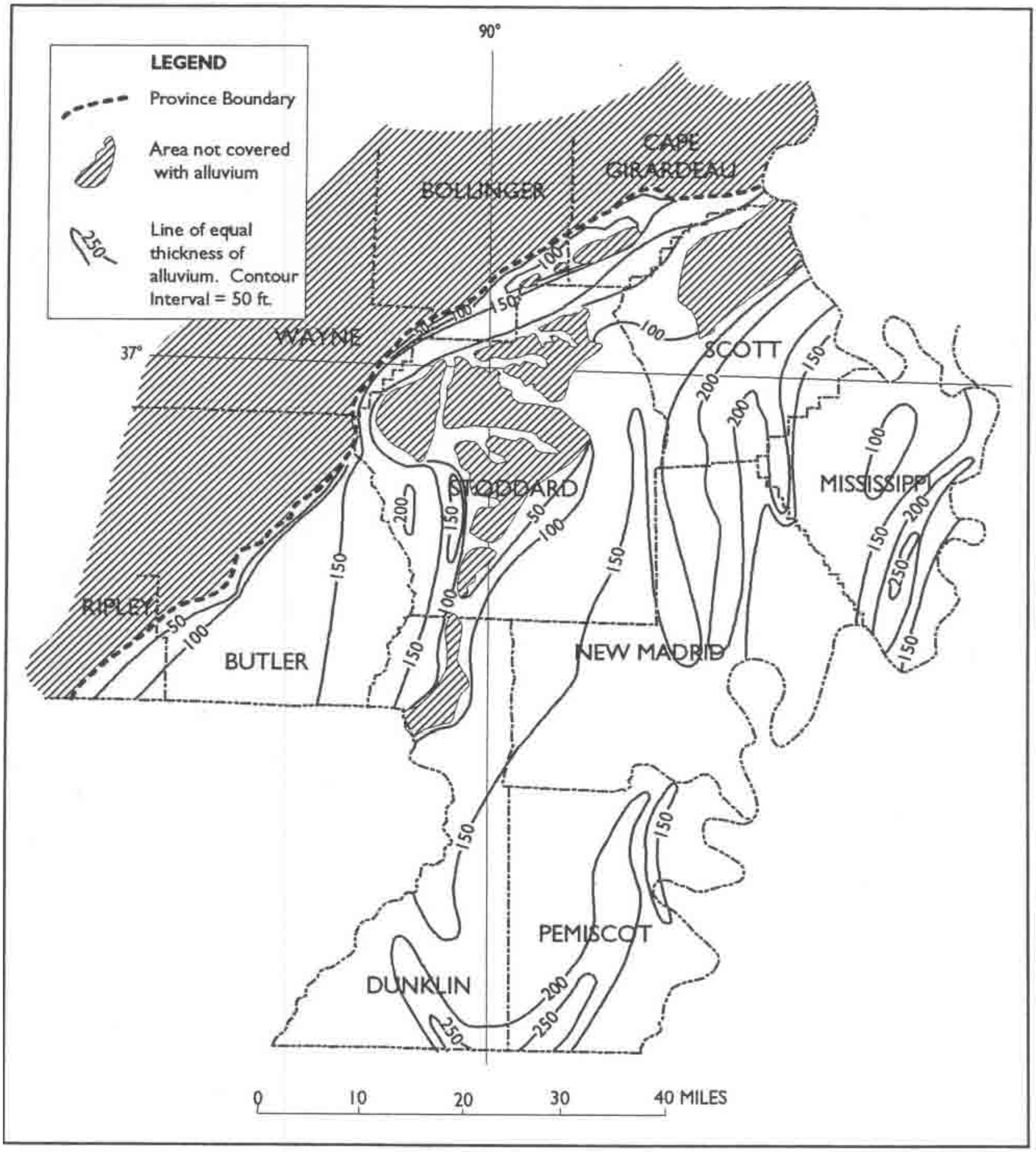


Figure 44. Thickness and extent of the Southeastern Lowlands alluvial aquifer (from Luckey, 1985).

sion Channel. However, potentiometric data shows that the St. Francis River along the west edge of the Bootheel may actually provide some recharge to the alluvium (Luckey, 1985). Where permeable sands of the McNairy and Wilcox subcrop beneath the alluvium, there is downward movement of alluvial water into them. Also, there is groundwater movement laterally through the alluvial aquifer in Missouri into northern Arkansas.

During spring, summer and early fall months there is a seasonal lowering of water

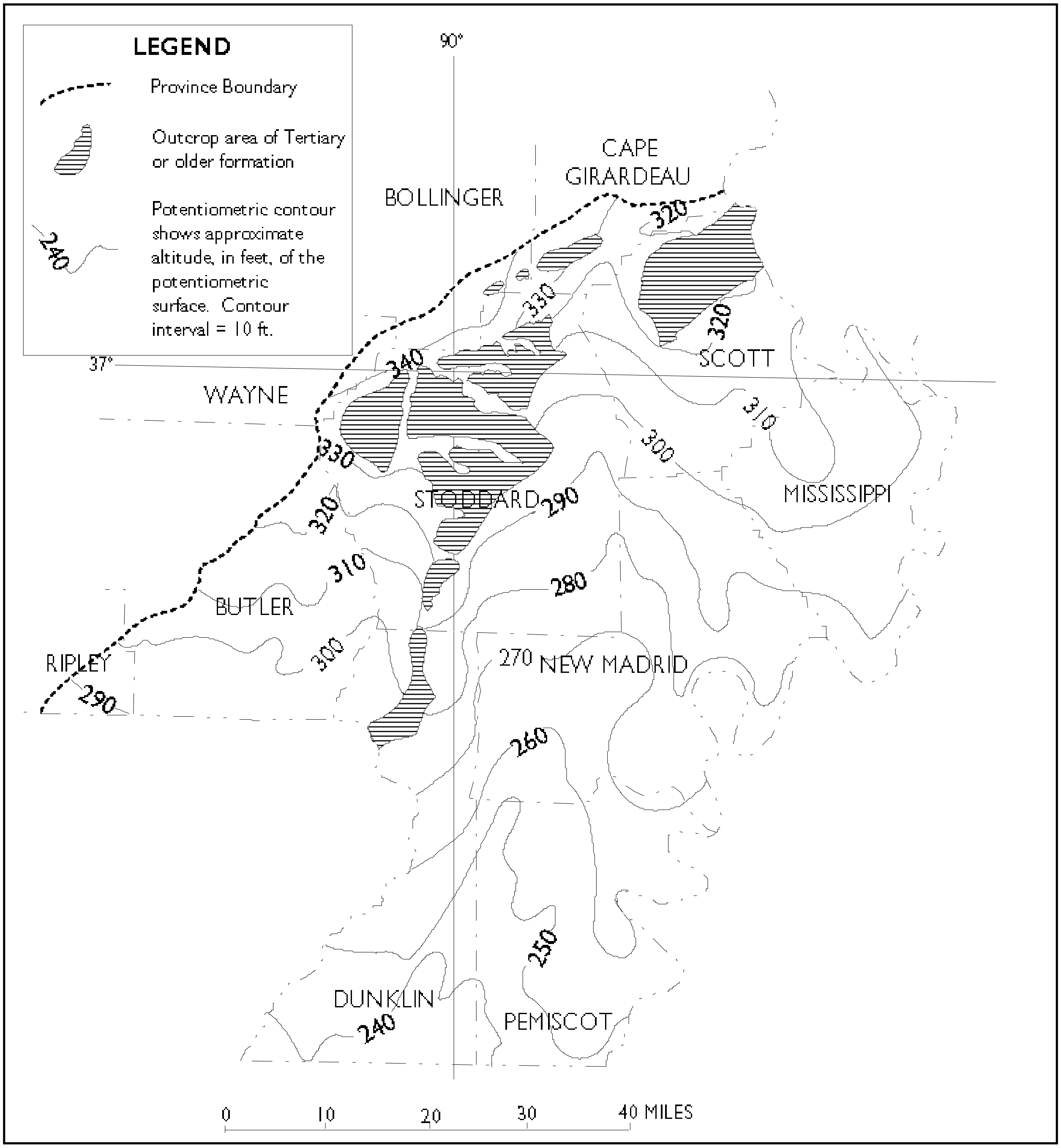


Figure 45. Generalized potentiometric surface of the alluvial aquifer in southeastern Missouri during the spring of 1976 (from Luckey, 1985).

levels within the alluvium that is partly in response to increased evapotranspiration. In areas where the water table is shallow, deep-rooted plants can use groundwater and will cause some lowering of water levels. Also, because of increased evaporation during warm weather, there is less recharge from the precipitation that does occur.

Under natural conditions, the lowest groundwater levels in the alluvium are usually in the late fall, and levels recover slowly throughout the winter, with the highest or

shallowest groundwater levels occurring in the spring when recharge from precipitation is highest. The artificial removal of groundwater from the alluvium by high-yield wells however, generally masks the effects of natural groundwater fluctuations.

In terms of the volume of water used and the number of wells that produce from it, the alluvial aquifer in the Southeastern Lowlands is by far the most extensively used aquifer in the Southeastern Lowlands. Private domestic wells in rural areas that produce from the alluvium are typically only a few feet deep to a few tens of feet deep. Most of these low-yield wells are driven sand points or jetted wells. Rotary drilling equipment is not widely used for domestic-type wells in the Southeastern Lowlands. These wells use water from the shallow part of the alluvium. This water generally contains less iron and manganese than the deeper alluvial materials. However, the upper part of the alluvium is typically more fine-grained than the lower part, and thus has a significantly lower hydraulic conductivity. Some public water supply wells that produce from the alluvium are also able to take advantage of the slightly better water quality in the shallower part of the alluvium.

The greatest usage of groundwater in the Southeastern Lowlands is for agricultural irrigation, and the most widely used aquifer for irrigation is the alluvial aquifer. Luckey and Fuller (1980) inventoried 3,091 irrigation wells in the Southeastern Lowlands, which they estimated to be about 75 percent of the total number of irrigation wells. Prior to passage of the Water Well Drillers Act in 1985, the Division of Geology and Land Survey received information for only a small percentage of the total number of wells drilled. However, after August 1987, drillers were required to file well completion forms on most types of wells including irrigation wells. Between January 1, 1987, and September 30, 1996, the Division of Geology and Land Survey received well records for 2,225 irrigation wells that were drilled during that period in Butler, Dunklin, Mississippi, New Madrid, Pemiscot, Scott and Stoddard counties. Nearly all of these wells probably produce from the alluvial aquifer. From this information, about 230 irrigation wells are drilled each year in the Southeastern Lowlands. Part of these are replacement wells for existing irrigation systems, while others are drilled to supply new irrigation systems. Based on the above there could currently be as many as 7,800 irrigation wells in the Southeastern Lowlands.

Long-term groundwater level monitoring throughout the Bootheel indicates that despite increased water use, there has been little or no net decline of water levels in the alluvial aquifer since the first water-level monitoring wells were installed in 1956. During the irrigation season, groundwater levels in many areas will decline several feet in response to pumping, but will recover during nonpumping intervals to their prepumping levels. In some instances, nearby private water supplies have been adversely impacted by irrigation pumpage, and have not recovered rapidly due to seasonal low water levels during the growing season, and continued irrigation pumpage.

Figure 46 shows the locations of groundwater-level observation wells operated in the Southeastern Lowlands by DGLS, and the years of record available for each well. Figure 47 shows long-term water-level information collected at several observation wells in the Southeastern Lowlands. All of the graphs show that despite the very large quantities of water used for agricultural irrigation, water levels in the alluvial aquifer have not changed appreciably since the first observation wells were installed in 1956.

Recharge to the alluvium throughout the Bootheel through precipitation, surface-water inflow and groundwater inflow is approximately 9.9 million acre-feet a year. Outflow from the system is through surface water leaving the area, evapotranspiration and groundwater outflow. Outflow includes water that leaves the area at the state line, discharge into the Mississippi River and recharge to the deeper aquifer units. Groundwater pumpage by irrigation and municipal/industrial users totals about 115,000 acre-feet a year (Luckey, 1985).

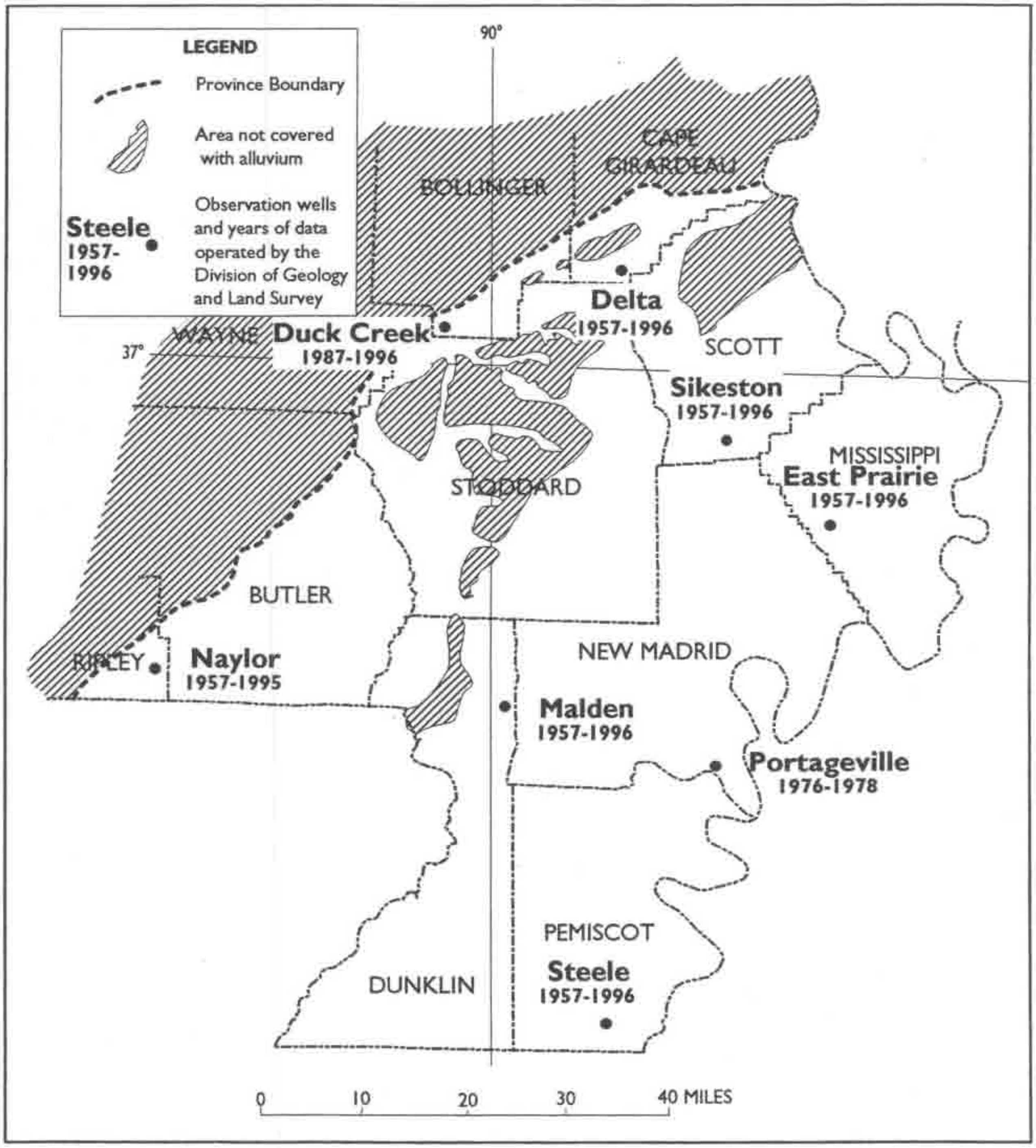
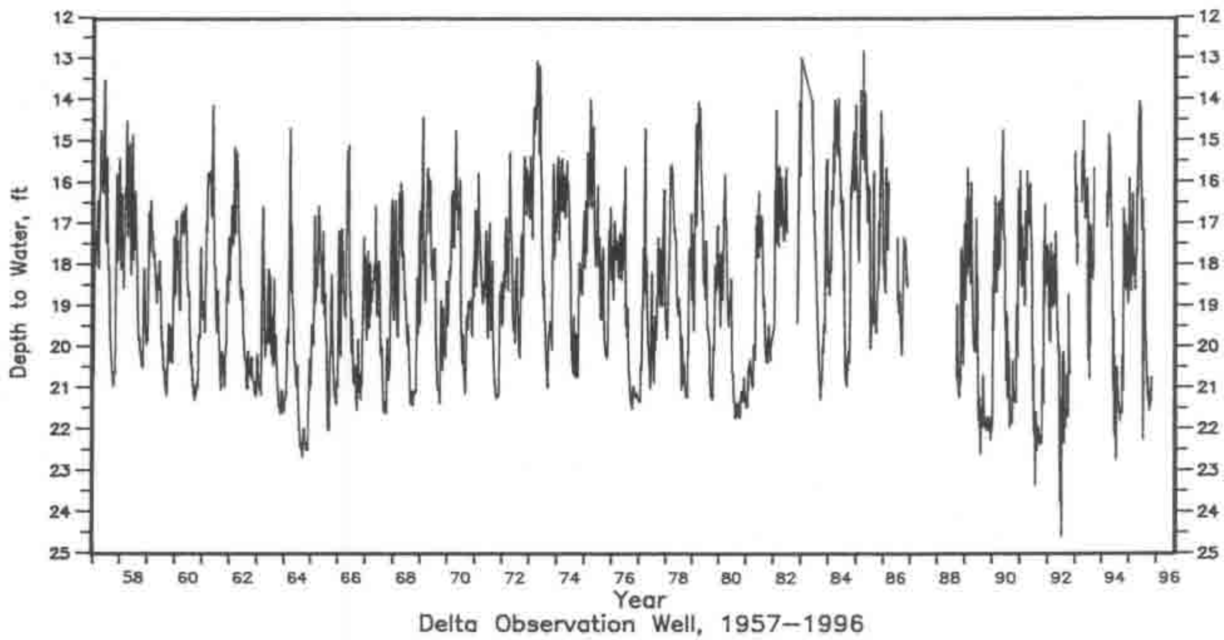


Figure 46. Locations of Southeastern lowlands observation wells operated by the Division of Geology and Land Survey.



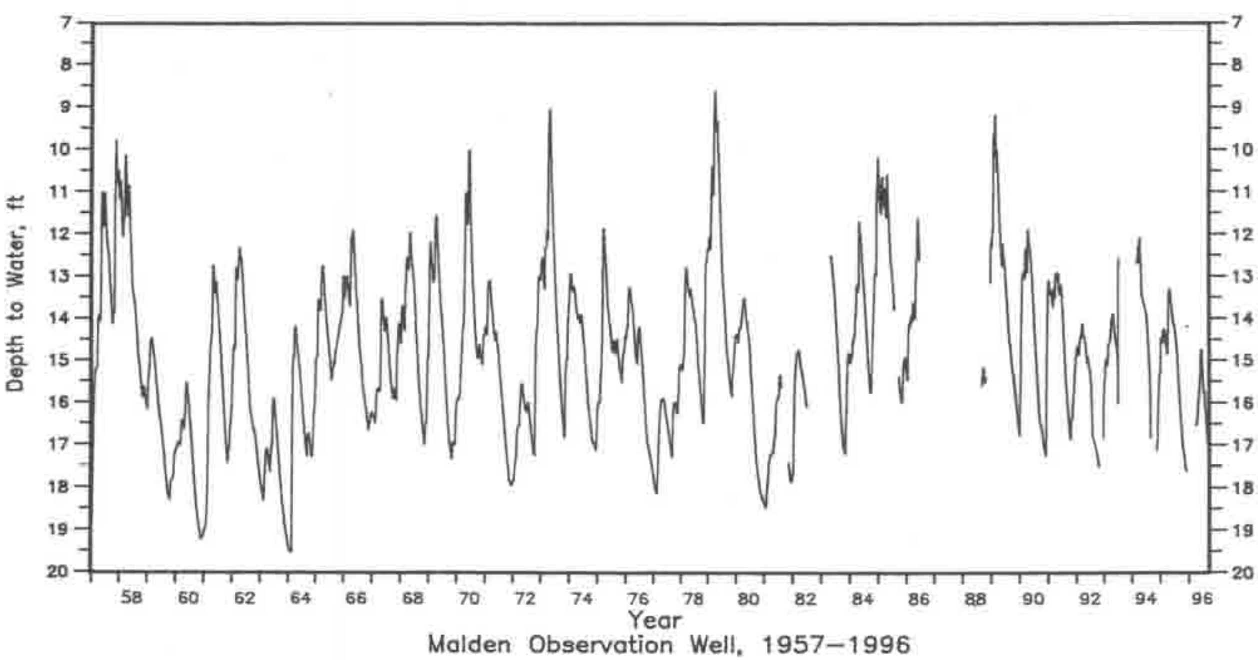
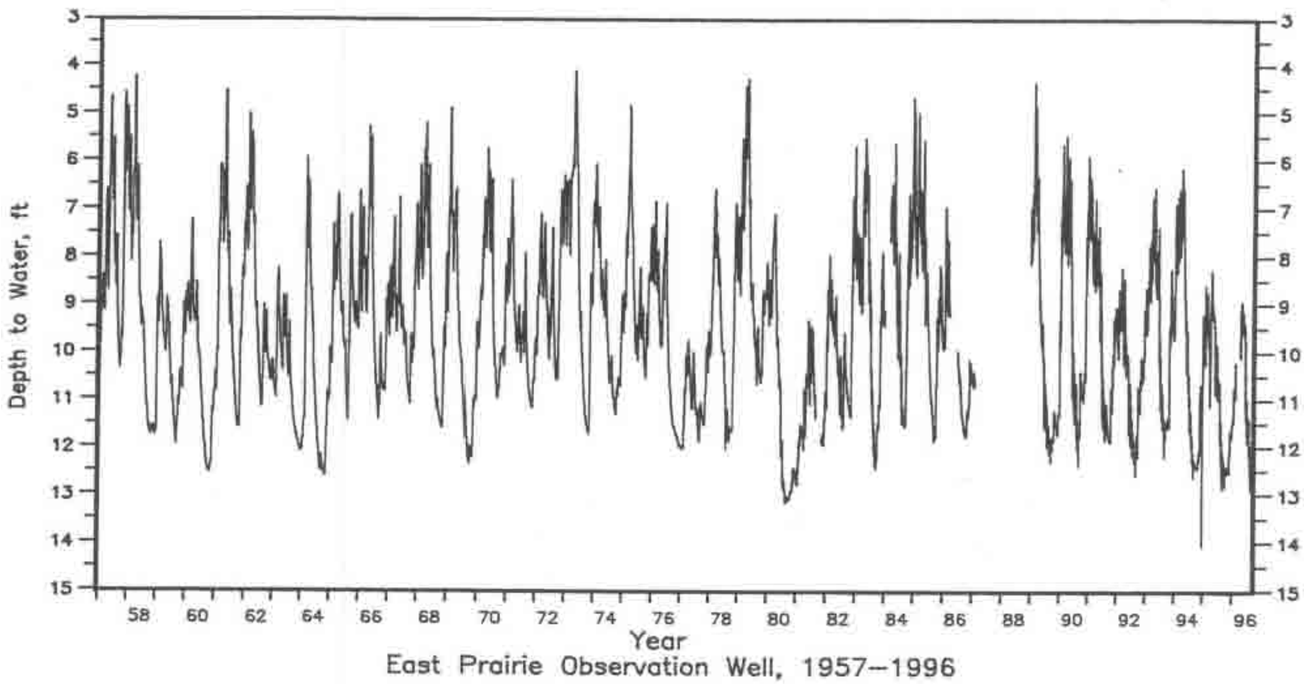
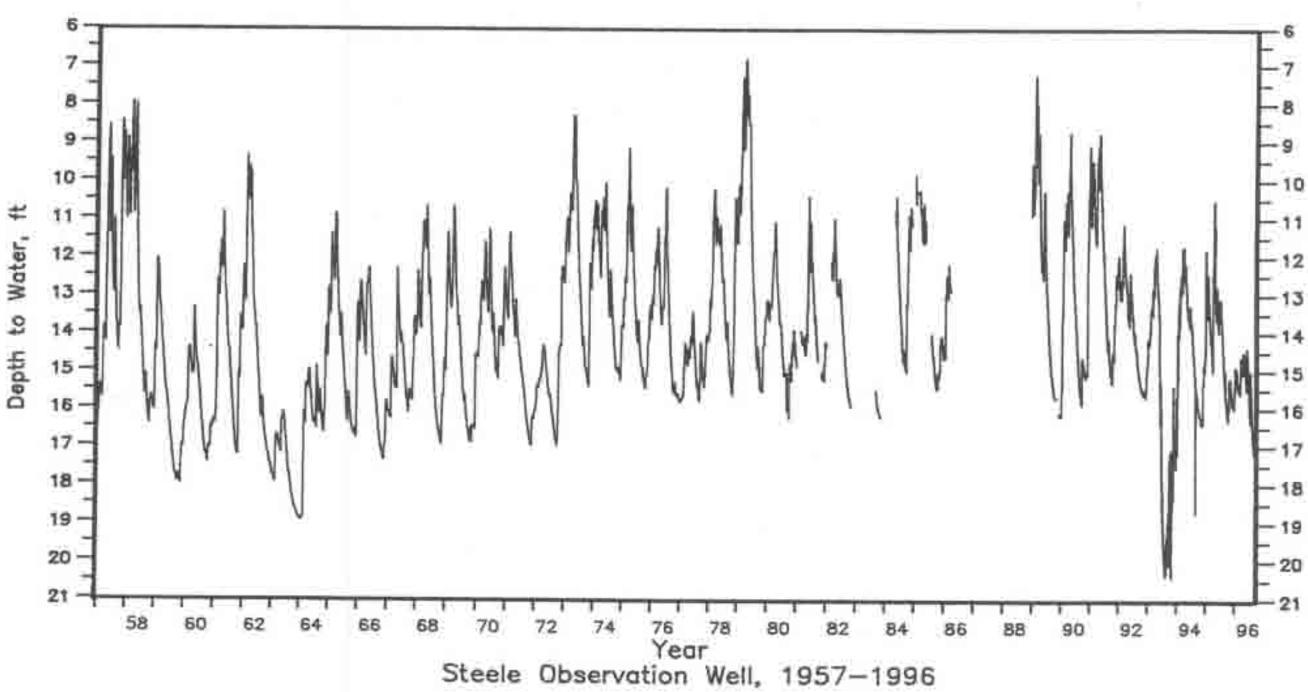


Figure 47. Long-term water-level changes at selected observation wells in the Southeastern Lowlands.

Figure 47 continued.





Luckey also assumed that about 60 million acre-feet of groundwater is stored in the alluvium at any one time, which represents six years of total inflow, 10 years of evapotranspiration, and 500 years of pumpage.

Storage estimates made during this study indicate that the average volume of water stored in the alluvial aquifer varies with season, but is typically about 21 trillion gallons, or about 65 million acre-ft.

WELL INTERFERENCE

If several adjacent alluvial irrigation wells are pumping concurrently, the drawdown cones can merge, and cover a fairly large geographic area (figure 48). If there are nearby, shallow driven or jetted domestic wells, lowering of water levels just a few feet can mean the difference between pumping water and having a temporarily dry well. This is especially true with domestic wells equipped with centrifugal pumps that can produce water only from relatively shallow depths. The pumping equipment used in the larger, high-yield wells allows for the pumping of water from greater depths than does the centrifugal pump wells commonly used in shallow wells.

During dry summer months when irrigation is occurring, the cone of influence produced by irrigation wells will lower water levels significantly in addition to the natural, seasonal water-level declines that occur during the drier times of the year. Where the soil is sandy and more permeable, some water will flow back into the aquifer, but only that portion which escapes evapotranspiration. In the more clayey soils, runoff from the fields into drainage-ways precludes much recharge from taking place.

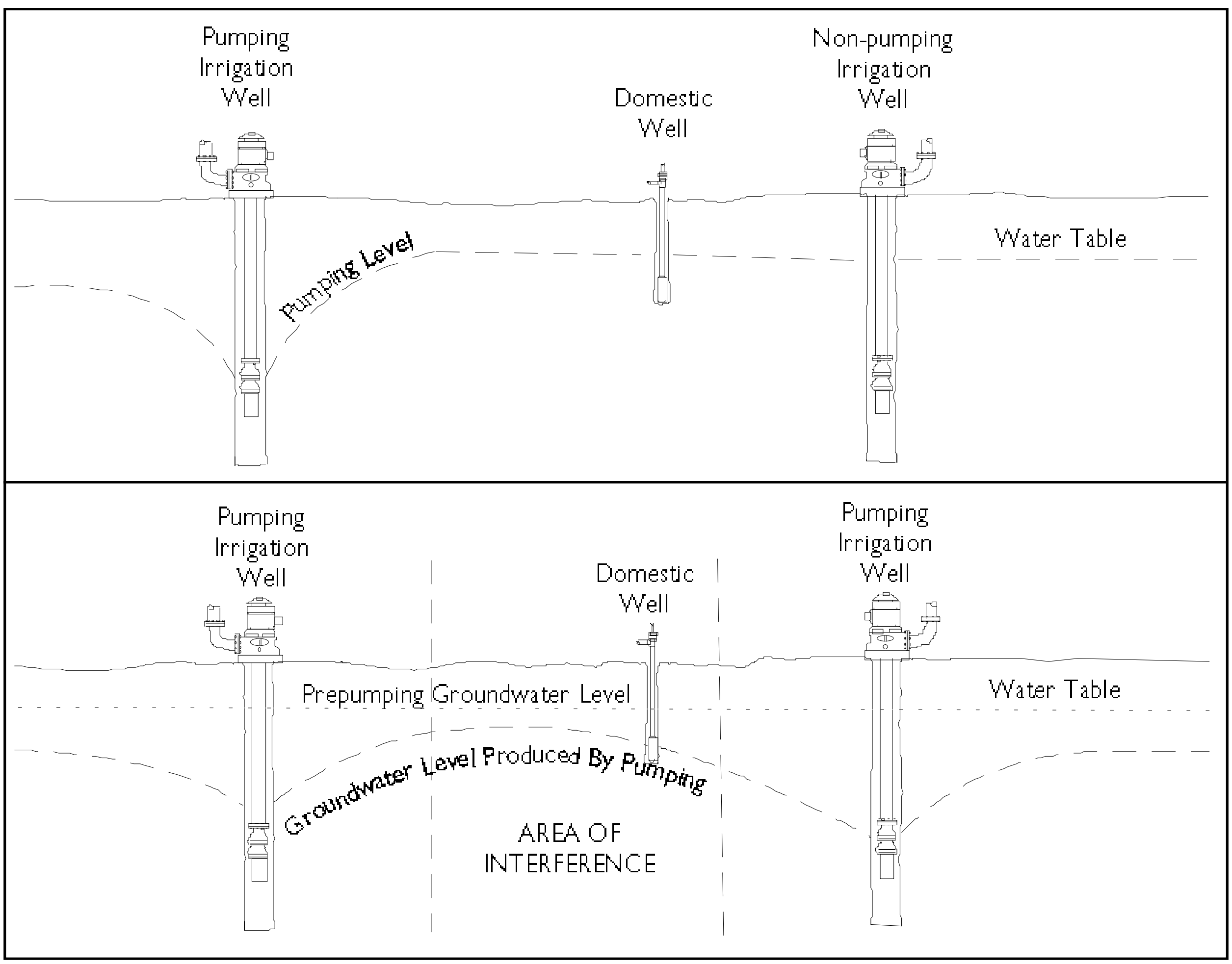


Figure 48. Generalized areas of interference from multiple pumping irrigation wells.

Well interference is best avoided by placing high-yield irrigation wells as far as possible from shallower, domestic wells. Still, problems are likely to occur, especially in areas where groundwater production is high, and wells of substantially different depths produce from the same aquifer. Historically, such disputes have been dealt with in civil courts.

GROUNDWATER CONTAMINATION POTENTIAL

The potential for groundwater contamination varies greatly in this region. All of the aquifers are prone to contamination in their outcrop areas. Sand units in the Wilcox Group are subject to contamination throughout the southeastern part of Crowleys Ridge where they are close to the surface and not protected by significant overlying aquitards. Where the McNairy Formation is overlain by the Midway Group, it is well protected from vertical contamination because of the low permeability of the Porters Creek Clay. Contamination potential of the Paleozoic bedrock aquifers from contaminant sources on Crowleys Ridge is fairly low. The Paleozoic units crop out over only a small area on Crowleys Ridge; the more productive units are quite deep, with substantial artesian-head pressures.

The complexity of the geology and water resources of the Crowleys Ridge-Benton Hills area makes careful siting of waste treatment and disposal facilities most important. Contaminant movement through sands in the Wilcox and McNairy aquifers would be relatively slow, but natural flushing of them would also be quite slow. Thus, contaminants introduced into these units would be very difficult to remove and clean-up costs would be quite high.

Because of its widespread occurrence and shallow position, the alluvial aquifer is probably the one most likely to be affected by contaminants. Since the Southeastern Lowlands are primarily an agricultural area, it may seem logical that agricultural chemicals such as pesticides, herbicides and fertilizers would be the most common types of contaminants. However, water-quality studies in the area have failed to discover significant evidence that this type of contamination is presently a problem, even in areas underlain by permeable, sandy soils. Sites that have the highest potential for this type of contamination are where agri-chemicals are handled such as at airports serving crop-spraying operations, and agricultural chemical distribution outlets. There are some sites of these types where groundwater contamination has been documented. Fortunately, such problems are relatively few.

Even though contamination due to the use of agricultural chemicals does not seem to be a major problem at the present time, it would be ill advised to assume that the unrestricted use of fertilizers, pesticides and herbicides in the Bootheel will not cause problems if proper precautions are not taken. The risk is further increased if chemicals are applied immediately before heavy rainfall when they are more apt to be carried by runoff into drainage-ways, and subsequently infiltrate into the shallow groundwater system. The potential for groundwater contamination also increases when chemicals are applied near improperly constructed irrigation wells or in the presence of abandoned wells. A common practice in the Southeast Lowlands is to use irrigation water to spray agricultural chemicals onto crops. Chemigation, the application of agricultural chemicals by mixing them with irrigation water as it is being sprayed, allows chemicals to be applied while irrigation is taking place. However, if not practiced with extreme care, this practice can be a source of groundwater contamination. Check-valves or other backflow prevention devices must be used to prevent the accidental introduction of chemicals into the well bore.

Use of chemical fertilizers has, in many areas of the United States, significantly raised nitrate levels in groundwater aquifers. Application rates that are in excess of what crops need for optimum production are often the cause of problems in these areas. This type of practice is costly in two ways. First, the farmer

is paying for fertilizer that is not increasing crop yields. Second, the surplus nutrients can leach downward through the soil zone and into the saturated part of the alluvium. Over time, increased nutrients in the shallow aquifer zones can adversely affect private water supplies, and in some aquifer settings, also affect public water supplies.

Contamination that occurs as a result of by-products produced by industries, pipelines, railroad accidents, municipal waste products, highway spills and a myriad of other sources, is a real possibility, and is known to have occurred at some locations in the Bootheel. For example, an unlined lagoon constructed on a sand ridge several miles north of Sikeston in Scott County allowed waste fluids generated by a metal plating operation to leak into the shallow alluvial aquifer. Thankfully, groundwater movement in the alluvium is generally slow, so these types of contamination events do not typically affect large areas. However, as the economy of the area continues to expand, even localized events can have a cumulative effect and could cause more widespread economic and social problems.

The avenues for contaminant transport in the Bootheel are numerous. The most common one is simply the vertical movement of contaminants through the soil, and into the shallow groundwater system. This is a particular problem in areas underlain by sandy, permeable soils. In areas underlain by more clayey, less permeable soils, the clay-sized particles have enough absorbent capabilities to trap fairly large amounts of the contaminants, and for this reason, large areas of the Bootheel are less vulnerable to this type of contamination. Figure 49 is a generalized soil map of the Bootheel showing areas underlain by tighter, clayey soils. Figure 50 shows the general appearance of a contaminant plume in alluvial sediments. This plume is based on a contaminant that is very soluble in water, and whose density is approximately the same as water. Insoluble contaminants that are more or less dense than water may generate contaminant plumes that differ greatly than the one shown.

Abandoned, unplugged wells present another avenue for contaminants to enter the groundwater system. They are essentially conduits for surface pollutants to enter the system very rapidly. In some areas, drainage wells have been used to drain water from areas that remain wet for long periods of time. This practice should be avoided since it can also introduce agricultural chemicals into the subsurface.

It is a good practice to avoid the mixing of agricultural chemicals at or near wellheads. If precautions are not taken, chemicals can be accidentally siphoned from sprayer tanks when they are being filled. This can occur if the check valve in a pump fails, or a large opening develops in the pump pipe in the well.

Leakage of surface retention lagoons used for agricultural runoff, municipal waste or agricultural waste products such as feedlots and swine or poultry production, are locally a source of elevated nitrate concentrations. This type of contamination is probably not as widespread as other sources, but, as mentioned above, does contribute to the cumulative total for the area.

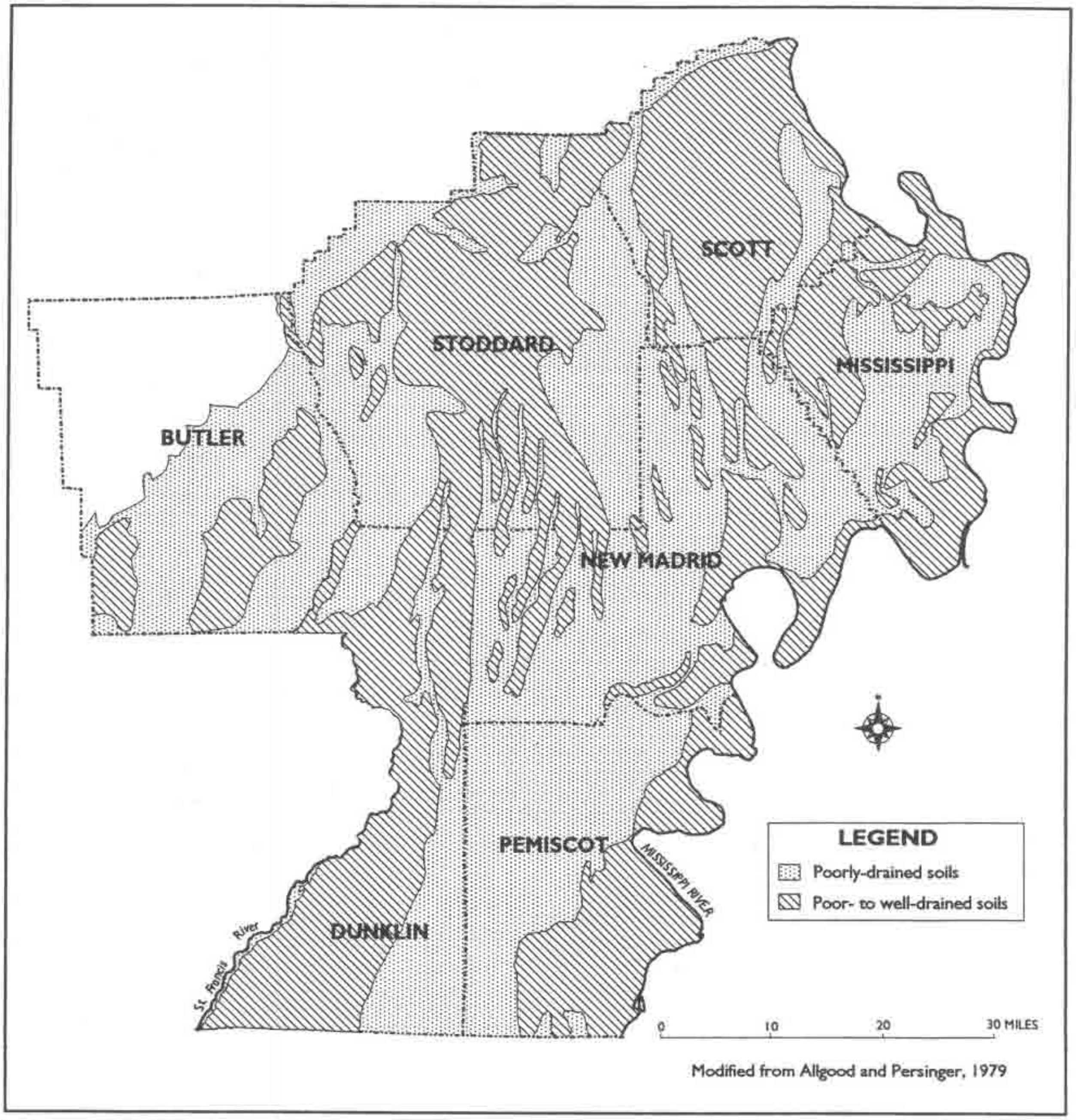


Figure 49. Generalized soil map of the Bootheel.

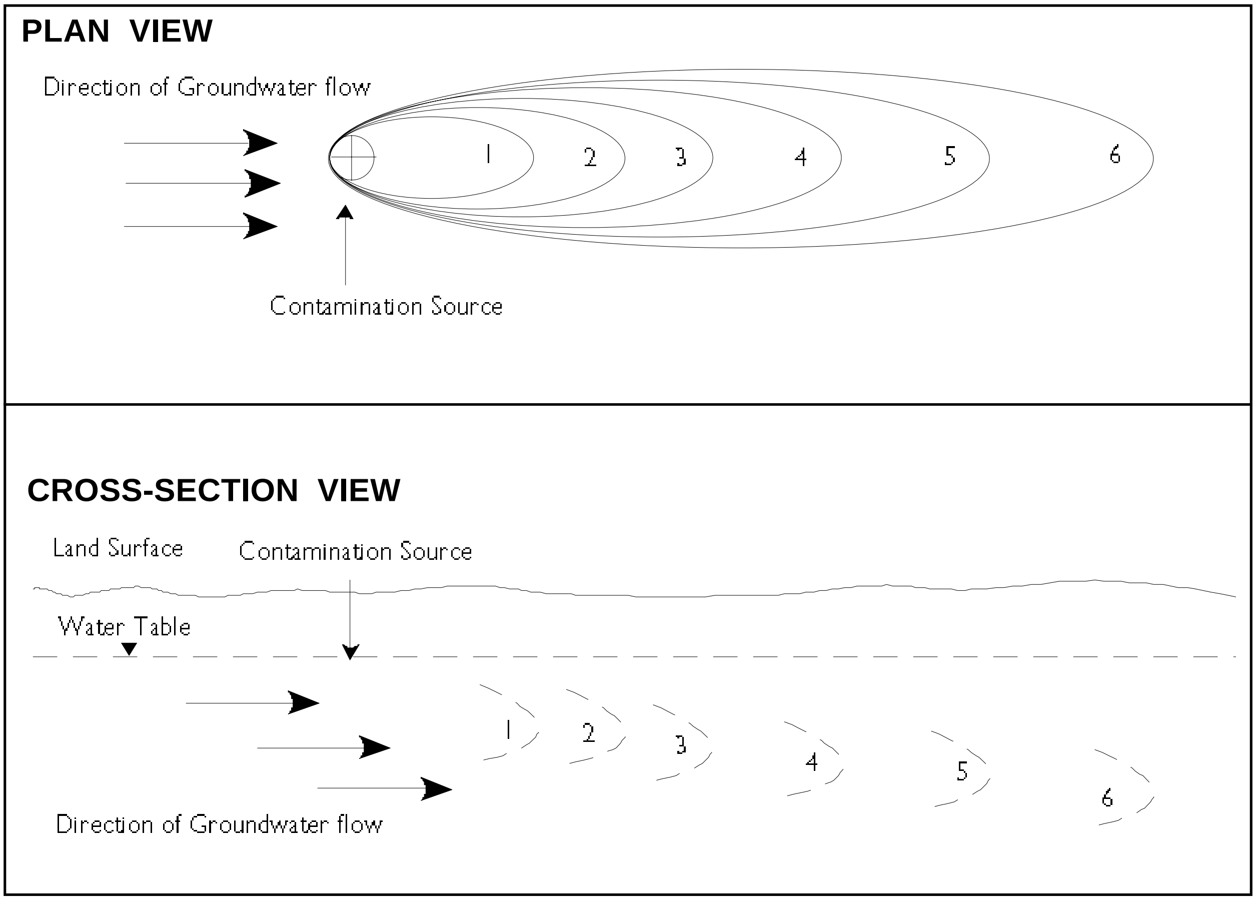


Figure 50. Plan view and cross-section of a hypothetical contaminant plume in an alluvial aquifer. Numbers indicate the limits of the plume at various times in its development.

MISSISSIPPI RIVER ALLUVIUM

INTRODUCTION

The alluvial aquifers beneath the flood-plains of the Mississippi and Missouri rivers are some of Missouri's most valued water resources. These aquifers are capable of yielding from 500 to more than 2,000 gpm to properly designed and developed wells, and are widely used for municipal water supply and agricultural irrigation.

The Mississippi River forms most of the eastern border of Missouri, and its total length in Missouri is 485 miles. This includes approximately 123 miles where it borders the Bootheel. A comparison of geologic maps of Illinois and Missouri quickly shows that the Mississippi River tends to follow the bluff line on the Missouri side of the river. With the exception of the Southeastern Lowlands, discussed previously, there are only a few locations in eastern Missouri where there is a significant amount of Mississippi River alluvium. These occur in eastern Clark and extreme northeastern Lewis counties, eastern Marion County and extreme southeastern Lewis County, eastern Pike, Lincoln and St. Charles counties, a small area in eastern St. Louis County, a small area in eastern Ste. Genevieve County, and an area in northern Perry County (figure 51). The total surface area of Missouri that is underlain by Mississippi River alluvium, excluding the Bootheel, is approximately 440 square miles. With such localized and small geographic distribution, the alluvium of the Mississippi River is not considered a major water source in Missouri. However, locally it is a very significant resource.

Where present, the alluvium ranges in thickness from a featheredge near the valley walls to approximately 170 feet; it is typically thickest adjacent to the river. In all cases, the alluvium was deposited by the action of the river, meandering back and forth across its valley over a several thousand year period. The position of the channel is much different today than it was in the past. Today, most of the significant areal extent of Mississippi alluvium is on the Illinois side of the river. There have been times in the past, however, when the channel was much further to the east, and hundreds of additional square miles of alluvium was west of the river.

The alluvium is composed of fine to coarse sand, fine to medium gravel, silt and clay. Because of the manner in which it was deposited, the extreme variability of the alluvium from one location to another makes it difficult to locate optimum high-yielding well sites. In almost all instances, test drilling is needed to determine the most favorable locations where there is the greatest thicknesses of high-permeability sands and gravels.

Because of the limited aerial extent of the alluvium of the Mississippi River in Missouri, discussion will be by county, from the northernmost occurrence in Clark County, to the southernmost occurrence, in Perry County. The alluvium in the Southeastern Lowlands was discussed previously and will not be readdressed here.

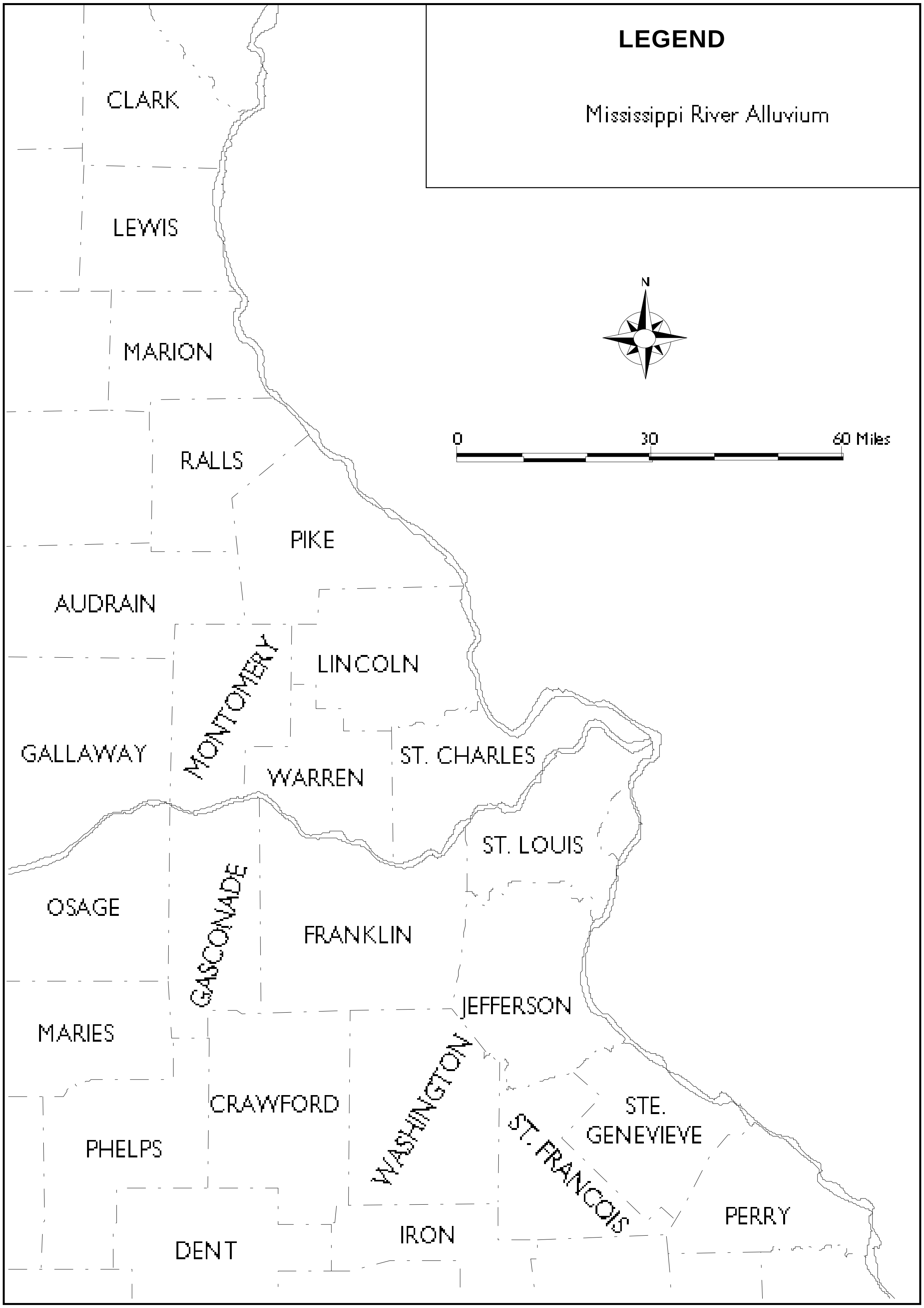


Figure 51. Distribution of Mississippi River alluvium in Missouri.

CLARK AND NORTHEASTERN LEWIS COUNTIES

A fairly large area of alluvium is found in eastern Clark County and extreme northeastern Lewis County, just south of the confluence of the Mississippi and Des Moines rivers. Alluvium here overlies an area of about 77 square miles. Prior to the deposition of the modern alluvium, and prior to the advance of the last continental ice sheets of the Pleistocene, the channel of the Des Moines River followed a much different path than does the modern river. The trend of this ancestral river was more southernly where it entered Missouri. It is not known if this drainage change was due to the effects of glacial ice diverting the flow to the south, and if the present day valley of the Des Moines is the preglacial route. However, there is a buried channel of the ancestral Des Moines River that underlies the alluvium of the Mississippi in Clark County. Figure 52 is a generalized map showing the possible configuration of this buried channel.

There are few wells that produce from the permeable zones in this buried channel. In 1971, the city of Kahoka in Clark County initiated an exploratory drilling program near the town of Wayland to find a source of municipal groundwater. This test drilling program delineated a small section of the channel, and one production well was drilled into it. As drilling progressed, the production well encountered 50 feet of shallow, modern alluvial materials, 55 feet of fine-grained glacial sediments, and finally 55 feet of preglacial, ancestral Des Moines River alluvium. During a controlled aquifer test, this well yielded 775 gpm, had a transmissivity of more than 33,000 gpd/ft (4,411 ft^2/day), and had a storage coefficient of 0.08.

In 1974, the Division of Geology and Land Survey installed a water-level recorder on a well at Wayland that is open to the ancestral Des Moines River alluvial channel. Figure 53 is a groundwater-level hydrograph, showing water levels for the Wayland observation well. It was noted shortly after the water-level recorder was installed that local precipitation had very little, if any, affect on groundwater levels. This is undoubtedly due to the poor vertical permeability between the preglacial valley deposits and the overlying alluvium of the Mississippi River. There are noticeable seasonal affects from spring through winter, but little or no response to individual rainfall events. Most of the water-level changes are due to pumpage of a nearby city of Kahoka well.

A few irrigation wells produce alluvial groundwater in this area. The average thickness of the alluvium here is only about 100 ft, somewhat less than in areas further to the south. There does seem to be a potential for increased use, however, since the average thickness of clean, permeable sand and gravel is large enough to yield 500 gpm or more to properly constructed wells.

As in other alluvial areas, the quality of the groundwater contained in the alluvium of this area is good, with the exception of fairly large concentrations of iron and manganese. However, production wells located near the present channel of the river should be able to induce recharge to the aquifer from the river, and thereby improve the quality of the production water from the well.

Storage estimates indicate that the Mississippi River alluvium in Clark County contains about 88 billion gallons of water in storage, or about 270,300 acre-ft. In northeastern Lewis County, the alluvium is estimated to contain another 20.2 billion gallons or 61,950 acre-ft. This is based on an assumed average saturated thickness of 80 ft, and a specific yield of from 0.08 to 0.11.

SOUTHEASTERN LEWIS AND MARION COUNTIES

Very little data are available for the 54-square-mile area underlain by Mississippi River alluvium in eastern Marion County and extreme southeastern Lewis County. However, as in Clark County, it is reasonable to assume that there is a sufficient thickness of permeable alluvial materials that can supply high yields to wells drilled in the alluvium. This is supported by data from two alluvial wells, drilled for industrial purposes in Sec. 3,

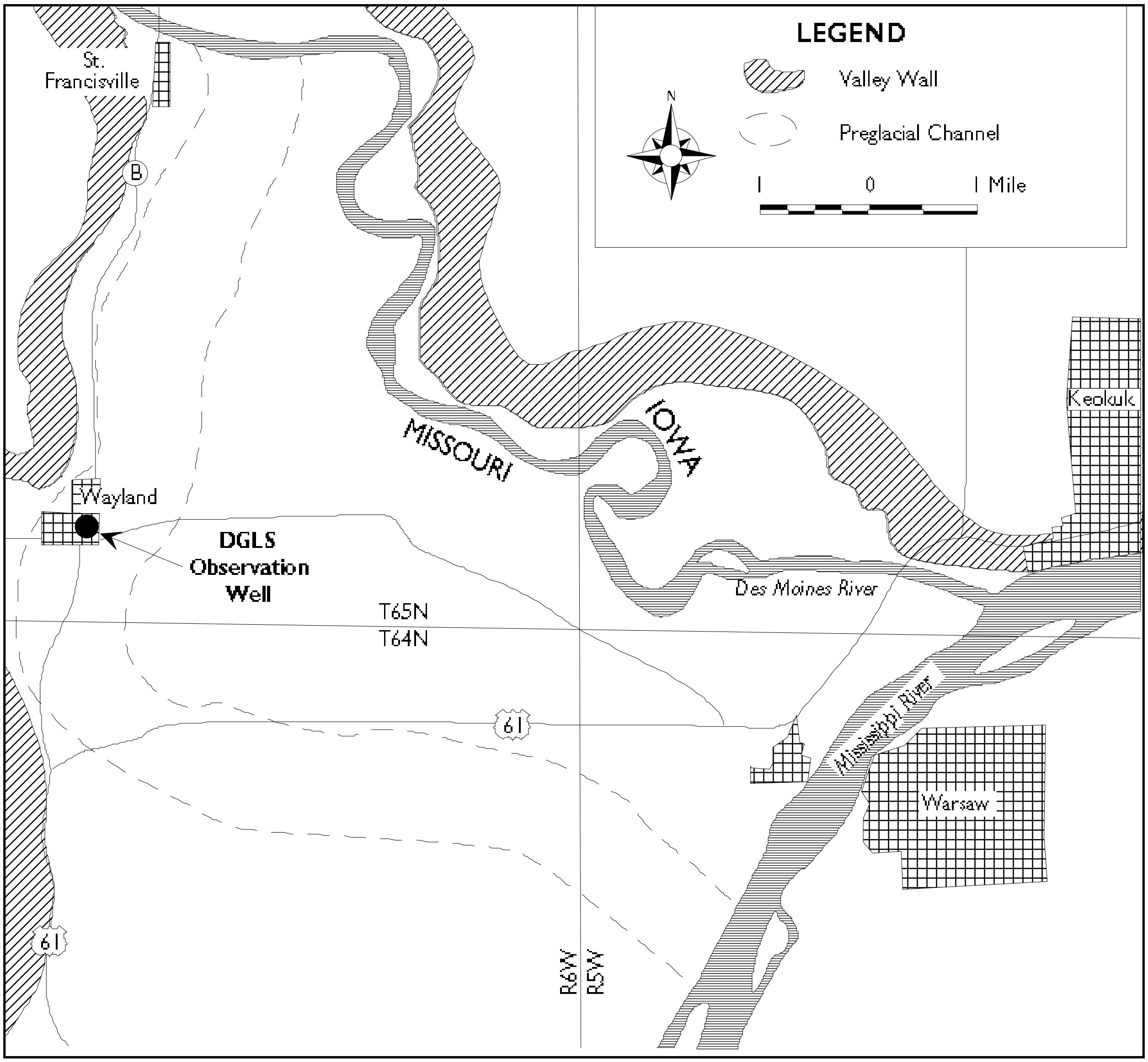


Figure 52. Possible configuration of preglacial Des Moines River channel in Clark County, Missouri.

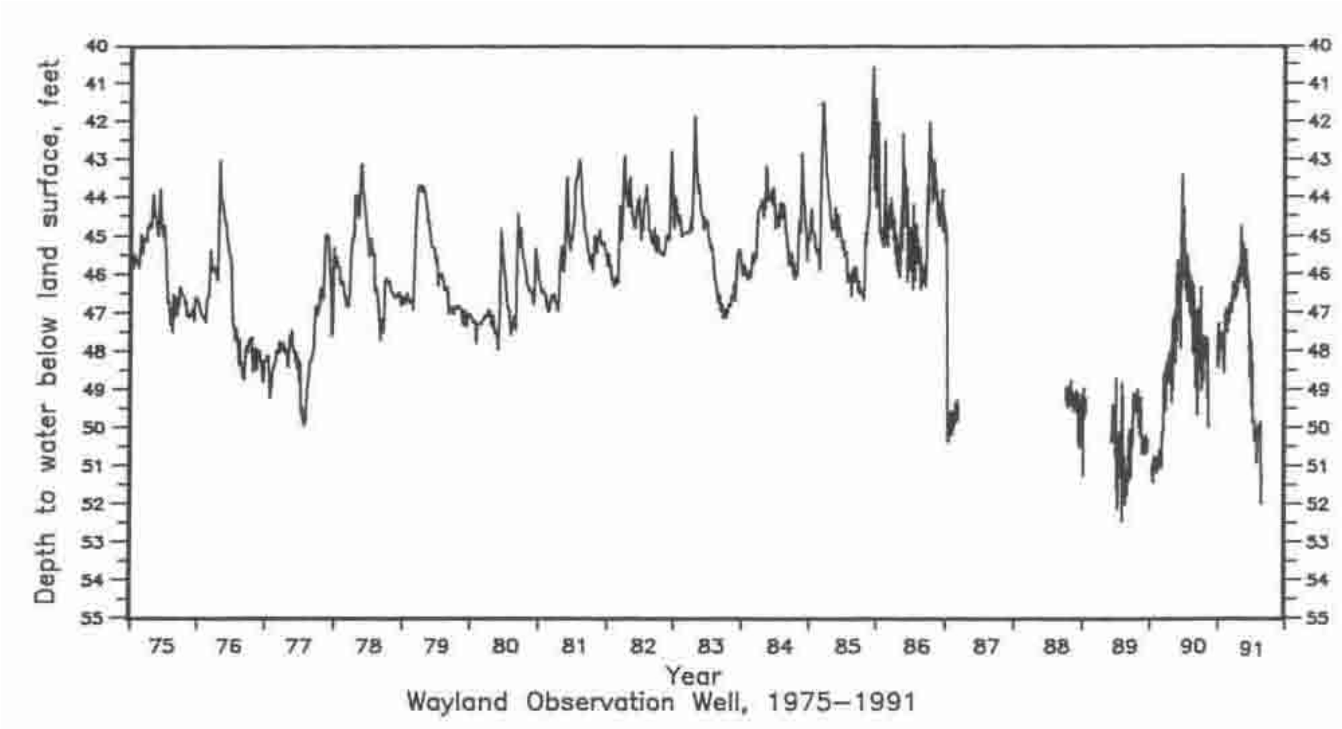


Figure 53. Groundwater-level hydrograph, Wayland observation well, Clark County.

T. 58 N., R. 5 W. These wells encountered 150 feet of alluvial material, and yielded 1,200 and 1,400 gpm. The Division of Geology and Land Survey has a groundwater-level recorder installed in an abandoned industrial well a short distance south of the aforementioned wells. Drilled in 1957 to a depth of 129 feet, this well had a yield of only 215 gpm, which was inadequate for its intended use. Instead of plugging the well, the owners donated it to the Missouri Geological Survey (now the Division of Geology and Land Survey) for its water-level measuring program.

This well shows water-level changes that reflect river stages. There is a delay time of about four days, between a rise in river stage, and a rise in water levels in the observation well. This is not to say that water is entering the alluvial aquifer and moving to the well. Since in this type of alluvial setting groundwater gradients in the alluvium are towards the river and slightly downstream, it simply means that the steepness of the gradient has been lessened by the "damming effect" of higher stream levels, and that groundwater is temporarily stored in the aquifer, raising water levels until the river stage drops.

In southeastern Lewis County, the alluvium is estimated to contain about 23.9 billion gallons of water in storage, or about 73,200 acre-ft. In Marion County, another 157.7 billion gallons or 483,800 acre-ft are estimated to be stored in the alluvium.

PIKE, LINCOLN, ST. CHARLES AND ST. LOUIS COUNTIES

In eastern Pike County, at the mouth of the Salt River, is an area of about 18 square miles underlain by Mississippi River alluvium. Very little data exists for this small alluvial area. A much larger alluvial area begins farther downstream in Pike County. Extending from Clarksville in Pike County, to the confluence of the Missouri and Mississippi rivers in northeastern St. Louis County, is the longest continuous reach of Mississippi River alluvium in Missouri other than in the Bootheel. This area contains a total of about 230 square miles of Mississippi River alluvium.

There are no data available in DGLS files for alluvial wells in Pike County, but data from wells in Lincoln County, T. 49 N., R. 2 E., show that the Mississippi River alluvium there has a good potential for both municipal and irrigation use. In 1957, the city of Winfield drilled an alluvial well that yielded 197 gpm. Although this yield may appear small, the well had only 1.9 feet of drawdown during pumping. The specific capacity of this well is in excess of 100 gpd/ft, and the aquifers transmissivity here is estimated to be about 150,000 gpd/ft (20,000 ft^2/day). This well was developed in only 71 ft of alluvial material. A nearby irrigation well, drilled to a depth of 68 ft, yielded 1,570 gpm with a drawdown of 13.9 ft. Specific capacity for the well was 115 gpm/ft of drawdown, and from this transmissivity is estimated to be 173,000 gpd/ft (23,100 ft^2/day).

Based on well completion reports provided by water well drillers, numerous irrigation wells have been drilled in the alluvium since 1985 between the towns of Winfield and Old Monroe, and also between Old Monroe and the confluence of the Mississippi and the Missouri rivers. Thicknesses of alluvial material in these wells averaged about 90 ft, and thicknesses of 150 ft in some parts of the valley are possible.

Storage estimates for the Mississippi River alluvium in Pike and Lincoln counties indicate that this aquifer in Pike County contains about 77.4 billion gallons, or 237,600 acre-ft, while in Lincoln County it contains 124.4 billion gallons, or 381,600 acre-ft.

There are more data for the Mississippi River alluvial aquifer in northern St. Charles County. Thicknesses of 150 to 170 ft have been reported, with yields as high as 2,000 gpm not being unusual. Drawdowns of properly constructed and developed wells pumping large amounts of water have usually been less than 10 ft. This implies that specific capacities of 200 gpm/ft are possible, and that transmissivities could approach 300,000 gpd/ft (40,000 ft^2/day). Although few irrigation wells have been reported in the alluvium of St. Charles County, there are numerous wells in the area that are used to flood large, shallow ponds at private waterfowl hunting clubs. There has also been widespread industrial use of the alluvial waters.

There is an area in the alluvium, just to the north of the city of St. Peters, in which the alluvial waters have elevated chloride levels. Here, the city of St. Peter uses six wells in the Mississippi River alluvium as a raw water source. Five of the wells are within an 11-acre tract; the sixth well is a short distance to the east. Production reportedly ranges from 400 gpm to about 1,500 gpm, and chloride content is about 130 mg/L. Since this area is on the eastern side of the freshwater-salinewater transition zone, the elevated chloride levels may be due to leakage of highly-mineralized groundwater from bedrock horizons into the alluvium.

The lithologic characteristics of the alluvial deposits are varied. The Mississippi alluvium is composed of silt, clay, fine- to coarse-grained sand, and fine to medium gravel. Since the alluvial materials were deposited by a meandering river throughout a several thousand year period, there is no areal uniformity; nor is there any continuity in the vertical sequence of deposits. However, generally there does seem to be coarser, more permeable material near the center of the valley or near the channel of the river, and finer material near the valley walls, especially near the base of the alluvium.

With the exception of counties in the Southeastern Lowlands, St. Charles County contains the greatest volume of groundwater in the Mississippi River alluvium—about 563 billion gallons or about 1.73 million acre-ft.

There is a small area of the city of St. Louis underlain by alluvial material associated with the Mississippi River. This area, locally known as Columbia Bottom, is about an 8.8-square-mile area located just south of the confluence of the Missouri and the Mississippi rivers. This area has alluvial thicknesses that average about 120 ft. The Division of Geology and Land Survey has maintained a groundwater-level observation well in Columbia Bottoms for almost 30 years. This well is 125 feet deep and shows fluctuations in water levels that closely mirror river-stage changes on the two rivers. Water levels below land surface average approximately 20 ft during normal years. In 1993, however, as river stages rose, water levels in the well rose in response. When flood waters were at floodplain elevation, groundwater levels were also essentially at land surface. Despite the fact that the casing for this observation well extends about 10.5 ft above ground level, the recorder was completely inundated after the levy failed during the 1993 flood.

The Mississippi River alluvium in St. Louis County and city is estimated to contain about 30.3 billion gallons, or about 93,000 acre-ft of water in storage during average periods. Although the overall quality of the alluvial water is generally good and is more consistent than that of Mississippi and Missouri river water, all of the St. Louis City and County public water supplies use intakes in the Missouri, Mississippi and Meramec rivers as raw water sources.

STE. GENEVIEVE COUNTY

A small area of about 8-square miles in eastern Ste. Genevieve County is underlain by Mississippi River alluvium. Very little data exists for this area except for a municipal well drilled for the city of St. Marys. St. Marys is perched on the edge of the Mississippi River floodplain in an area where the Illinois-Missouri state line is only a few hundred feet northeast of the town. However, the Mississippi River is nearly four miles farther to the northeast. The Mississippi River changed its path here during a flood in 1881, leaving a 24-square-mile area of Illinois called Kaskaskia Island on the west side of the river. St. Marys' well was completed in an area of the alluvium, close to the edge of valley where the alluvial deposits are relatively thin. The well is only 53 feet deep, and only the lower 25 feet had sand coarse enough to be water-productive. The yield of the well reflected the lack of permeable sand and gravel, being only about 50 gpm. If St. Marys had constructed the well a few thousand feet farther to the east, in Illinois, it would likely have had a considerably better yield.

The volume of water stored in the Mississippi River alluvium in Ste. Genevieve County is relatively small, about 12.5 billion gallons, or about 38,400 acre-ft.

PERRY COUNTY

The area in northern Perry County underlain by alluvium is one for which very little data are available. The Division of Geology and Land Survey has logs of only two wells that penetrate the alluvial material in this 43-square-mile area. These wells indicate that there is at least 150 feet of alluvium, and that the alluvial material consists of fine- to coarse-grained sand, and fine to medium gravel. The hydrologic characteristics of the alluvium here are probably similar to those of the alluvium in the Bootheel further to the south. The potential for high-yield alluvial wells is good, but only a test-drilling program will establish a suitable site where sufficient permeable sands and gravels are present.

The 43-square-mile area of Mississippi River alluvium in Perry County is estimated to contain about 175 billion gallons of groundwater, or about 536,600 acre-ft.

GROUNDWATER QUALITY

Water produced from the Mississippi River alluvium, like that of the alluvium in the Southeastern Lowlands, generally meets public drinking water standards with the exception of iron and manganese. The elevated levels of these constituents are particularly high where the production wells are located a considerable distance from the river. Deeper alluvial water may contain higher levels of these metals than shallow alluvial water. Data indicates that high-yield wells drilled close to the river will induce recharge from the river, and both iron and manganese will be significantly lower. Most municipal water supplies that use alluvial water have extensive treatment plants that are capable of removing the excess iron and manganese. It is not uncommon for the alluvial water to contain iron in excess of 20 mg/L, and have manganese concentrations of more than 3 mg/L, far in excess of recommended levels of 0.3 mg/L and 0.05 mg/L, respectively.

MISSOURI RIVER ALLUVIUM

INTRODUCTION

The Missouri River forms the western border of Missouri between Iowa and Kansas City, and bisects the state between Kansas City and St. Louis where it enters the Mississippi River, a total distance of about 533 miles. Like the Mississippi River, the Missouri River has carved a valley that contains up to about 150 ft of highly-permeable alluvial sediments. The alluvium underlies the Missouri River flood-plain, which in Missouri ranges in width from zero, where the river hugs the bluff line in several places, to a maximum of about 12 miles. In general, the valley is widest up-stream from Glasgow in Howard County. Between Glasgow and St. Louis, the valley is generally two to three miles wide.

The Missouri River, as it exists today, is much different than its ancestral counterpart that existed prior to Pleistocene time. Prior to the advance of the continental ice sheets into what is now Missouri, it is thought that the ancestral channel of the Missouri River in northwestern Missouri followed a route near what is now the Grand River. The Grand River confluence with the Missouri River today is at the southern edge of Chariton County. The part of the Missouri River valley between Kansas City and Chariton County was formerly occupied by the ancestral Kansas River. The modern Kansas River joins the Missouri at Kansas City. Continental ice sheets several thousand feet thick are responsible for the drainage changes. As the glaciers advanced into Missouri, the ancestral Missouri River was blocked with ice. Water from the drainage upstream of the blockage was diverted to the south and west, forming new drainage channels. After the melting of the ice sheets, the original drainage patterns were not reoccupied. The geomorphology of the valley upstream from the confluence of the Grand, and the placement and number of upland stream terraces, seem to confirm this theory.

Melt water from glaciers during the Pleistocene generated tremendous volumes of runoff, carrying immense quantities of sediment that had to be transported by the Missouri River. In response, the river carved a much deeper and wider channel than the river occupies today. Glacially-derived sediments ranging in size from clay particles to boulders were transported in the melt water. A considerable thickness of the sediments was deposited within the river valley to form the Missouri River alluvial aquifer.

The Missouri River alluvium is a very important and widely used water source in Missouri. Twenty-five counties in Missouri border the Missouri River, and nearly all of them make use of water available from the alluvium. Wells drilled into the alluvium supply much of the water for numerous rural water districts, towns and cities including Kansas City, Independence, Columbia and St. Charles. In addition, hundreds of high-yield irrigation wells are used throughout the reach of the Missouri River to enhance agricultural production.

As with the Mississippi River, there is direct interchange between the river and the alluvium. Groundwater levels are directly related to the stage of the river, although there is a delayed response of several days between higher river stages and higher groundwater levels. Figure 54 is a water-level hydrograph of a groundwater-level observation well completed in the alluvium of the Missouri River at Jefferson City and maintained by the Division of Geology and Land Survey. River stage data from the U.S. Geological Survey gaging station at Boonville, about 20 miles upstream of Jefferson City, are also shown. Seasonal river stages are illustrated by the gradual decline of water levels during the fall and winter months, and the gradual rise of groundwater levels starting in early spring through summer months. It can also be seen that, unlike bedrock wells located in the Ozark Province, the alluvial aquifer does not respond appreciably to local rainfall events.

Depending on location and local geology, the Missouri River alluvial aquifer can either be confined or unconfined. In places, the upper 20 to 30 ft of the alluvium consists of low-permeability materials. The potentiometric surface of the aquifer is typically within a few feet of the water-surface elevation of the river. Locally, the base of the clay and silt may be below the potentiometric surface, causing artesian conditions to exist. In other places, particularly those where there is a relatively thin clay and silt cap and the uppermost alluvial materials are very sandy, the aquifer is unconfined and water table conditions exist.

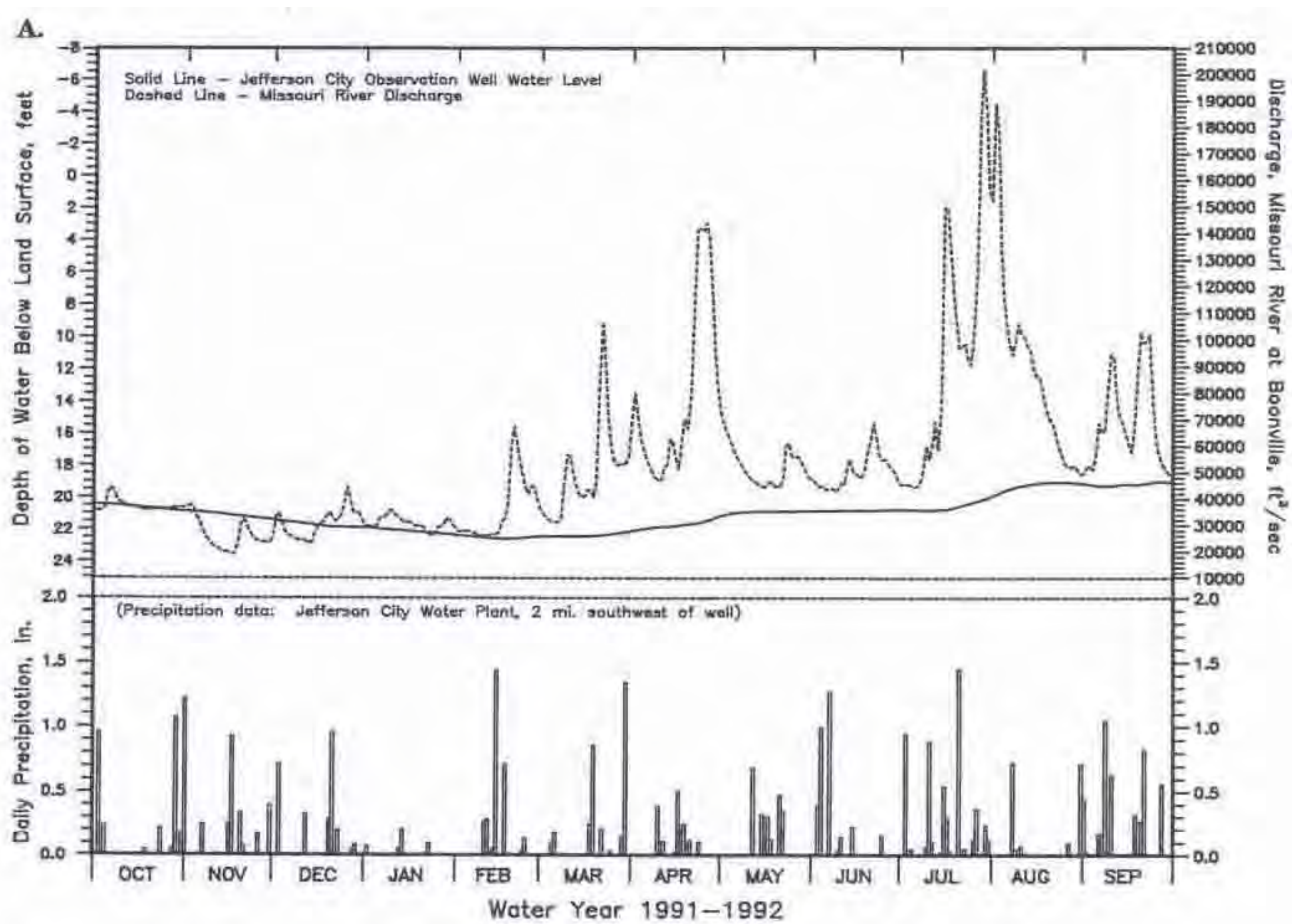


Figure 54 a & b. The relationship between groundwater level, Missouri River discharge and local precipitation at Jefferson City. Figure 54a shows relatively low river flow during the first half of water-year 1991-1992.

Although confined conditions are locally possible, under normal conditions alluvial wells cannot be under flowing artesian conditions. An exception to this is where levies have been constructed along the river. During flood periods, the potentiometric surface of the alluvial aquifer could be high enough to allow alluvial wells to flow near the river. Water levels in the alluvium normally range from less than five feet below land surface to approximately 20 ft below land surface. In most instances, the elevation of the drill site or well above river level dictates what the static water level will be.

When the Missouri River is under normal flow conditions, groundwater gradients in the Missouri River alluvium are towards the river, with a vector of about 45 degrees in a downstream direction. These gradients are very gentle, generally less than one to two feet per mile, and the velocity of groundwater movement through the alluvium is quite slow. Assuming an aquifer transmissivity of 200,000 gpd/ft (26,700 ft^2/day), a saturated thickness of 75 ft, a hydraulic gradient of 2 ft/mi, and an effective porosity of 30 percent, groundwater velocity is about 0.5 ft/day. This is a very low velocity when compared to those measured in the thick carbonate aquifers in the Ozarks where, under certain conditions, velocities can exceed a mile per day. The reason for such low hydraulic gradients and slow velocities is that the flow in the alluvial sediments is intergranular flow, or flow between the individual sand or gravel particles, whereas the flow in carbonate systems is usually along solutionally

B.

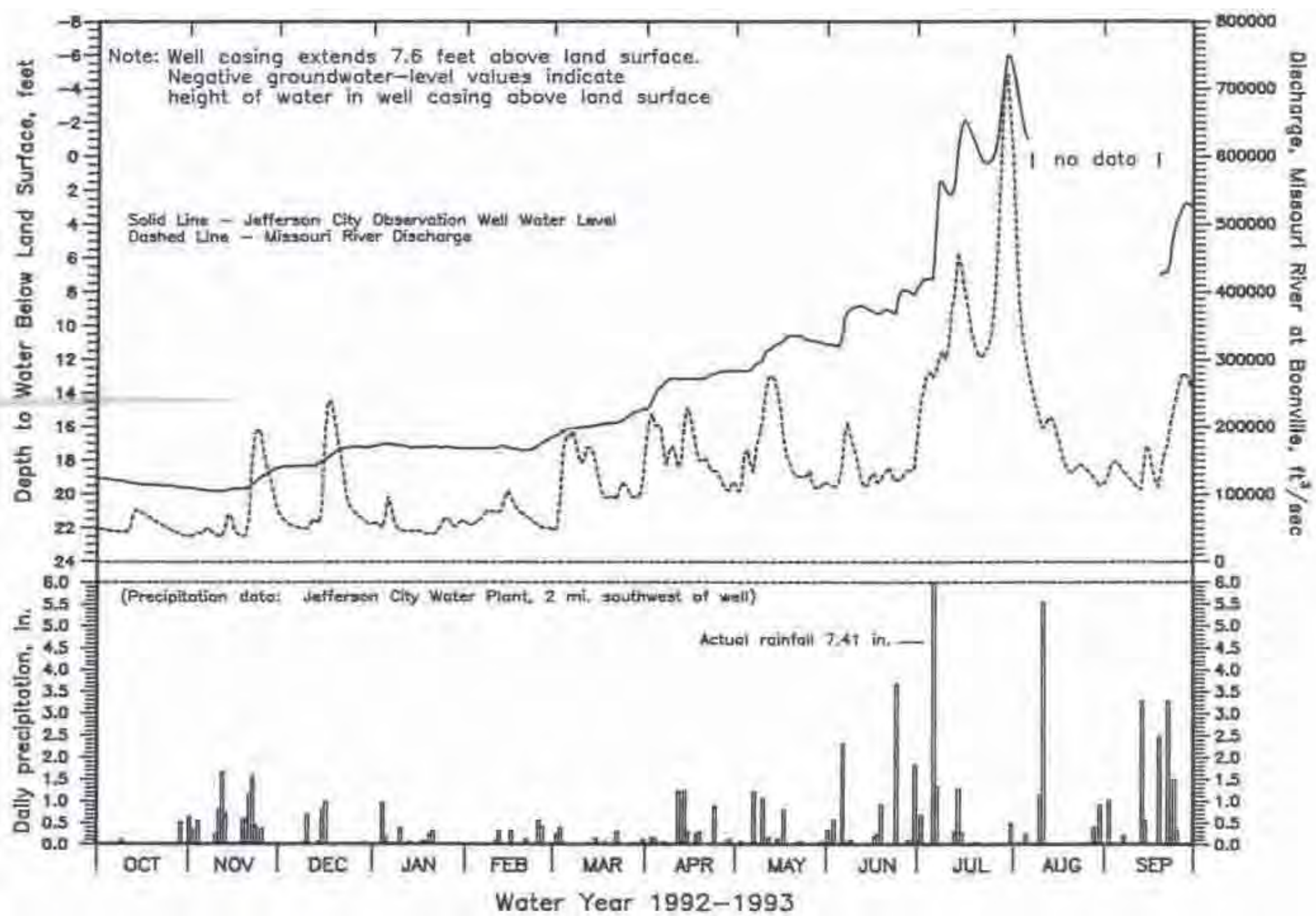


Figure 54b. The effect of prolonged high river stages on water level in the alluvial aquifer was very apparent during the Great Flood of 1993. (River discharge measured at Boonville.)

enlarged cracks and crevices, and in cave-like conduits.

The Missouri River alluvium receives recharge from four sources: infiltration from the Missouri River, from bedrock adjacent to and underlying the alluvium, from precipitation falling upon the floodplain, and from downward leakage of water from streams flowing across the alluvium. Water from the Missouri River recharges the alluvium generally under two conditions. When the river is at a high stage, that is above the elevation of the potentiometric surface, there is recharge of the alluvium from the river. Recharge also occurs where high-yield wells are constructed close enough to the river so that when they are pumped they induce direct recharge from the river to the well. The potentiometric surface of bedrock aquifer units adjacent to the Missouri River is normally above the potentiometric surface of the alluvial aquifer. Thus, there is groundwater movement from the bedrock into the alluvium. The volume of water supplied by precipitation, and the volume of recharge that occurs from other streams as they cross the Missouri River alluvium, depends greatly on the hydrologic characteristics of the shallow alluvial materials. In areas where the surficial materials are sandy and permeable, the amount of recharge water is significant. Where there is a clay or silt cap overlying the more permeable deposits, the recharge is less.

The alluvial materials of the Missouri River valley are composed of clay, silt, fine to coarse sand, and fine to medium gravel. The size of the alluvial materials typically increases with depth; finer-grained materials directly underlie the land surface and coarser sands and gravels are found at greater depth. This clay or silt cap overlying the more permeable sands and gravels, where present, will retard infiltration of surface water. Since these sediments were deposited by a meandering stream over long periods of time, there is no definite sequence of deposition at any particular site. The alluvium ranges in thickness from a featheredge at the edge of the valley to as much as 150 ft. The alluvium is generally the thickest in the center part of the valley near the river, but there are instances where the thickest materials are near a valley wall.

The volume of water stored in the Missouri River alluvial aquifer varies somewhat, but is estimated to be about 3.3 trillion gallons, or about 10.2 million acre-ft. The county containing the greatest volume of storage is Holt County, where the alluvial aquifer underlies an area of about 182 square miles, or about 40 percent of the county. Here, the saturated thickness of the aquifer averages about 80 ft, and it is estimated to store about 455 billion gallons, or about 1.4 million acre-ft. Gasconade County contains the least volume of water in the Missouri River alluvium. Here, the river tends to follow the valley wall on the Gasconade County side of the river, and alluvium underlies only about seven square miles. The volume of water in the alluvium in Gasconade County is estimated be about 18 billion gallons, or about 55,300 acre-ft.

For ease of discussion, the Missouri River, from its entrance point in extreme northwestern Missouri to its confluence with the Mississippi River at the eastern edge of the state, has been divided into four reaches; the Iowa border to Kansas City, Kansas City to Miami in Saline County, Miami to Jefferson City, and Jefferson City to St. Charles (figure 55). These divisions are not arbitrary. The U.S. Geological Survey (Emmett and Jeffery, 1968, 1969a, 1969b, 1970) prepared a series of hydrologic atlases to describe the groundwater characteristics of the Missouri River alluvium and used the same boundaries. Since this is the most detailed information available for much of this alluvial aquifer, the present report will follow the same format.

IOWA STATE LINE TO KANSAS CITY

A 1968 study conducted by the U.S. Geological Survey (Emmett and Jeffery, 1969b) is the most recent investigation of the Missouri River alluvium in this reach. At that time, nine communities, 12 industrial well fields, and approximately 50 irrigation wells were using alluvial water in this 446-square-mile area. Considering the poor bedrock groundwater

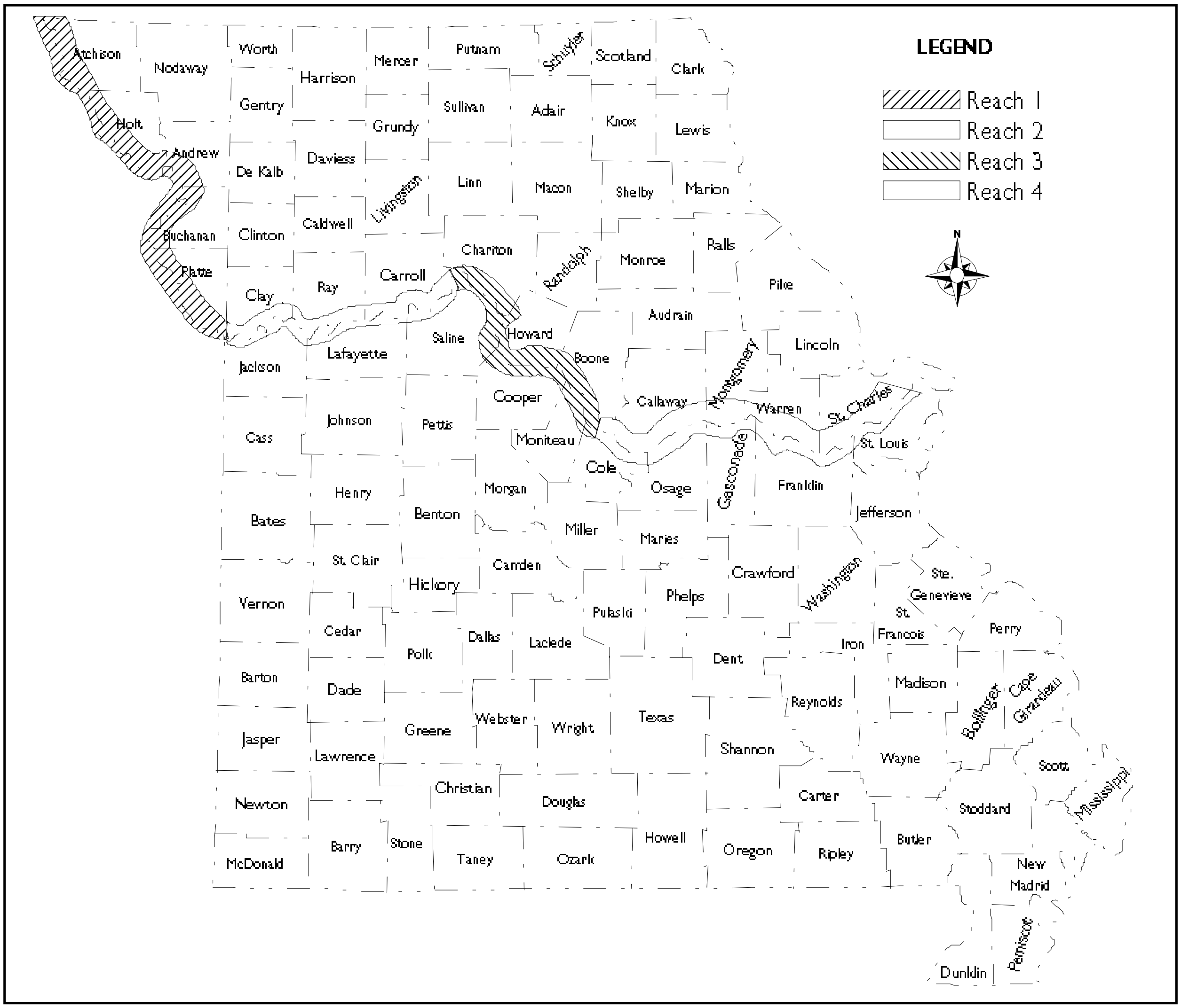


Figure 55. Index map showing locations of the four reaches of the Missouri River alluvium discussed in this report.

resources of this area, and the periods of drought experienced in this part of Missouri in the late 1970s and early 1980s, it is quite probable that these numbers have increased significantly, particularly the number of irrigation wells.

The average thickness of alluvium in this reach has been reported to be approximately 90 feet (Emmett and Jeffery, 1969b) and the average saturated thickness is about 80 feet. It generally consists of several feet of clay and silt near the surface, underlain by sand and gravel (figure 56). The alluvium in this area is underlain by Pennsylvanian-age shales, limestones and sandstone. The Pennsylvanian-age units are not considered important aquifers. They yield very little water, and the water they contain is generally too highly mineralized for most uses.

There are glacial deposits in upland areas adjacent to the river valley that may be hydraulically connected to the alluvium, and may recharge to the alluvium. Test drilling adjacent to this reach of the river has also found thicknesses of unconsolidated deposits, which indicate the presence of preglacial channels (Heim and Howe, 1962). Undoubtedly, these channels are connected to the alluvium of the Missouri River, but the volume of recharge they supply to the alluvium is not currently known.

The alluvium is recharged by infiltration from the river in upstream reaches, infiltration

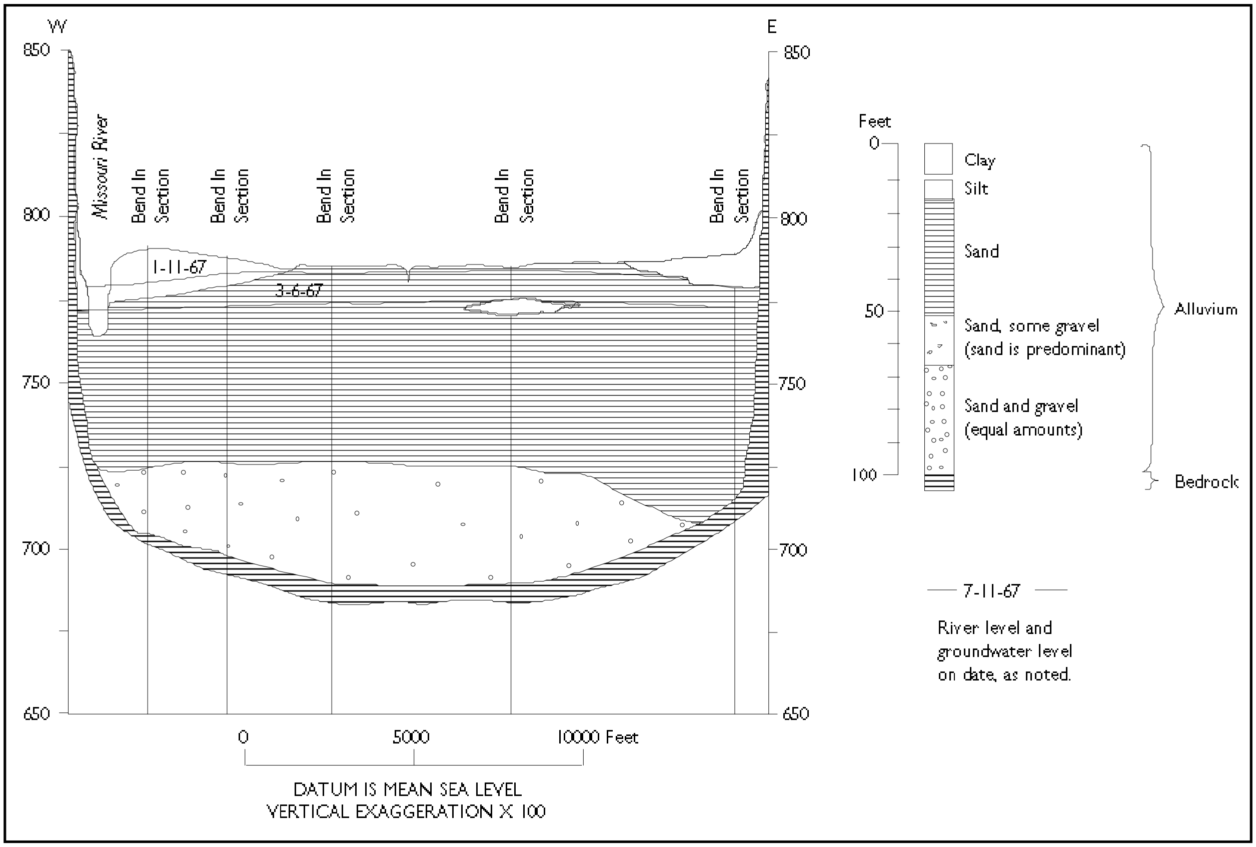


Figure 56. Cross-section of the Missouri River alluvium near St. Joseph, Missouri (from Emmett and Jeffery, 1969b).

from streams flowing across the alluvium and towards the river, by infiltration or leakage of water from bedrock sources, and precipitation. Recharge from precipitation is probably about 6 inches per year, or about 1.86 million gallons per year per square mile, which is a very small amount when compared to recharge the alluvium receives from the river. Discharge from the alluvium to the river is the main source of depletion of the aquifer.

During prolonged drought periods when the river stage is low, discharge from the aquifer to the river is more pronounced. This is due to a steepening of the hydraulic gradient toward the river. During prolonged periods of high river stage, the gradient is reversed, and recharge from the river into the alluvium takes place. However, in either case, the largest amount of groundwater-level fluctuation always takes place in zones nearest to the river.

Early hydrologic work in the Kansas City area indicated that well yields from Missouri River alluvium averaged approximately 1,000 gpm with specific capacity averaging about 60 gpm/ft of drawdown (Fishel and others, 1953). Many wells in this reach of the river yield more than 2,000 gpm, and have specific capacities of 80 to 90 gpm/ft of drawdown. Assuming an effective porosity of 15 percent throughout this reach, and an average saturated thickness of 80 feet, it is calculated that the Missouri River alluvial aquifer normally contains about 1.1 trillion gallons, or about 3.4 million acre-ft during average periods. In 1968, the average computed use of the resource was only 18 mgd (Emmett and Jeffery, 1970), indicating that only a very small part of the total aquifer potential is being used.

Yields of individual wells can be increased if the well is located to induce re-

charge into the aquifer from the river. The reasons for this practice are to ensure better quality water, lower pumping costs and decrease drawdown in the well. This has the added advantage of creating lower entrance velocities into the well through the well screen, an important factor in reducing the rate of mineral incrustation on the screen. Incrustation, which is the deposition of minerals such as iron or calcium carbonate on the well screen, is caused by dissolved minerals precipitating on the well screen. Over a period of time, well-screen incrustation will cover the openings of the screen and greatly reduce well yield. The problem can be diminished by proper well design and construction, and proper pumping operations. The well should be designed and constructed to allow water to enter the well with minimal resistance. A well screen having a large percentage of open area will reduce the entrance velocity of the water and minimize drawdown. Pumping the well at a higher rate than that for which it was designed can lead to more incrustation. The permanent pump should be selected only after the well has been fully developed and pump-tested. This way, the most efficient pump can be selected to supply a volume of water the well can safely produce.

Despite these efforts, the yields of most alluvial wells will eventually decrease because of screen incrustation, and the wells will need to be serviced to recover the lost production. Cleaning the incrustation from well screens typically involves the introduction of muriatic (hydrochloric) acid into the well adjacent to the screen. The acid should have some sort of buffering chemical added to minimize the corrosive effect on the metal in the screen. The acid will dissolve the carbonate-rich scale or incrustation, and generally restore the production of the well to near its original value.

Groundwater quality in the alluvium of the Missouri River in this reach is rather typical of alluvial aquifers. In instances where the water is pumped from wells at some distance from the river, it is a moderately mineralized calcium-bicarbonate type, and is usually high in iron and manganese. Iron concentrations average as high as 6.0 mg/L and manganese averages about 3.0 mg/L. If the well is located near the river where increased infiltration from the river can be induced, then the total iron and manganese content will be much lower. In most instances, water treatment to remove iron and manganese is necessary if the water is to be used for municipal or domestic purposes. If wells are located in areas where appreciable amounts of leakage from bedrock sources is occurring, then the alluvial waters may contain elevated concentrations of both sodium and chloride.

KANSAS CITY TO MIAMI

The reach of the Missouri River from Kansas City to Miami in Saline County is approximately 109 miles long, and the areal extent of the alluvial aquifer is approximately 440 square miles (Emmett and Jeffery, 1970). Pennsylvanian-age limestones, shales and sandstones underlie the alluvium throughout most of this reach. These bedrock formations generally have very low hydraulic conductivities, and the water within them is generally highly mineralized in much of the area along this reach of the river.

The upper part of the Missouri River alluvium in this reach is composed of fine sand, silt and clay, while coarser sands and gravels comprise the deeper part of the alluvial fill. In this reach, the maximum thickness is approximately 140 ft, with an average thickness of about 85 to 90 ft. Water levels in the alluvium range between 5 and 20 ft below land surface, and the average saturated thickness is about 70 ft. Figure 57 is a cross section across the Missouri River valley near Miami, in Saline County, showing the character and thickness of the alluvial material.

Heim and Howe (1962) show numerous buried valleys in this reach of the river. Most noteworthy is what appears to be a cutoff meander of the ancestral Missouri-Kansas River near Lake City, in northeastern Jackson County, and a larger channel in Saline County, which starts near Malta Bend. The latter trends in a southeasterly direction and reconnects with the present Missouri

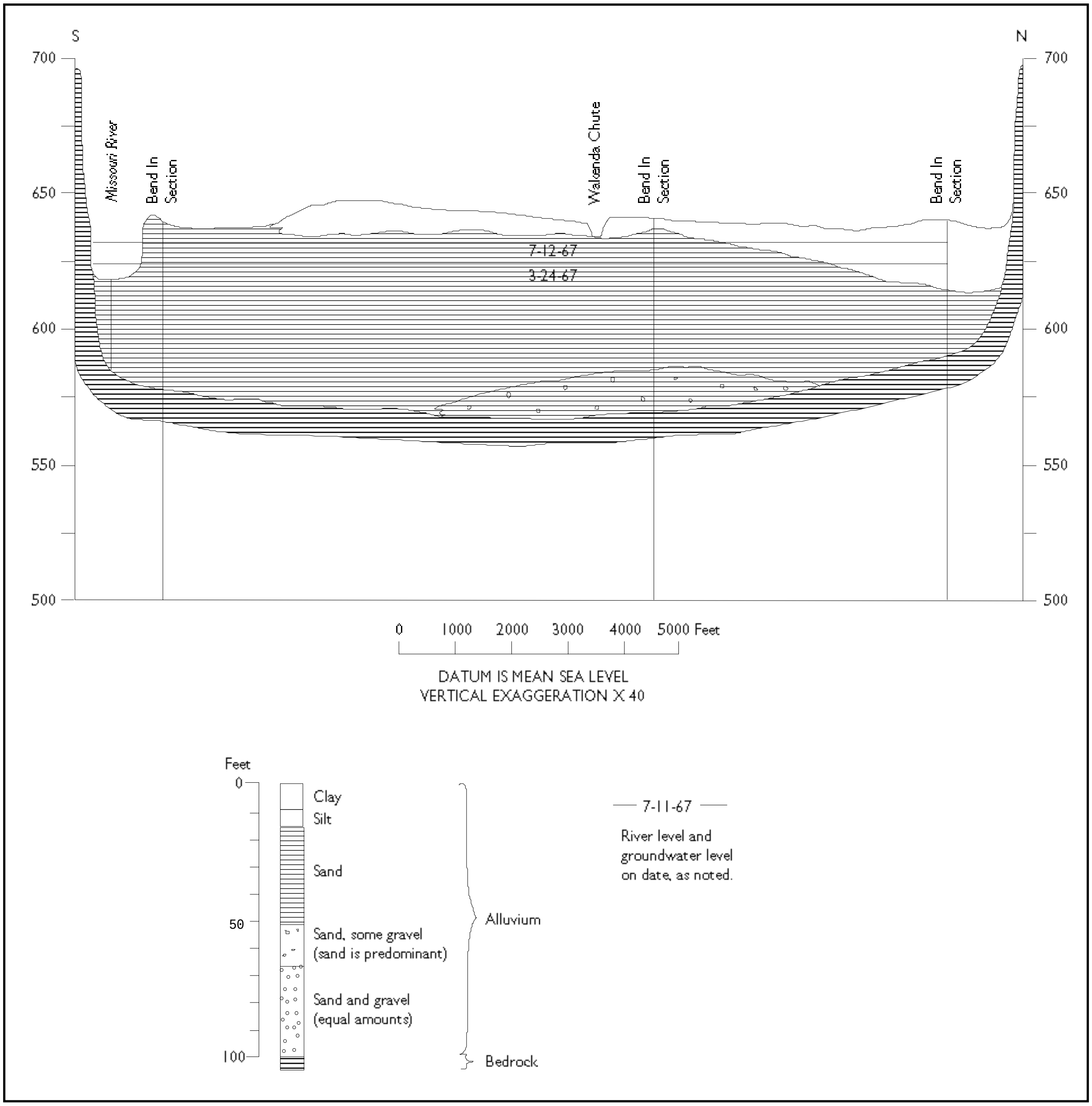


Figure 57. Cross-section of the Missouri River alluvium near Miami in Saline County (from Emmett and Jeffery, 1970).

River valley east of Arrow Rock in northern Cooper County, a distance of approximately 38 miles. This latter channel is probably the result of glacial damming or relocation of the river during glaciation. Figure 58 shows the approximate southern extent of glacial ice at its furthest encroachment into Missouri.

The development of terraces along the Missouri River, or any major river, is a subject that deserves mention. A terrace surface marks a former floodplain elevation. Downcutting or undercutting by the river during periods of degradation leaves the terrace at some elevation above the present floodplain. In some

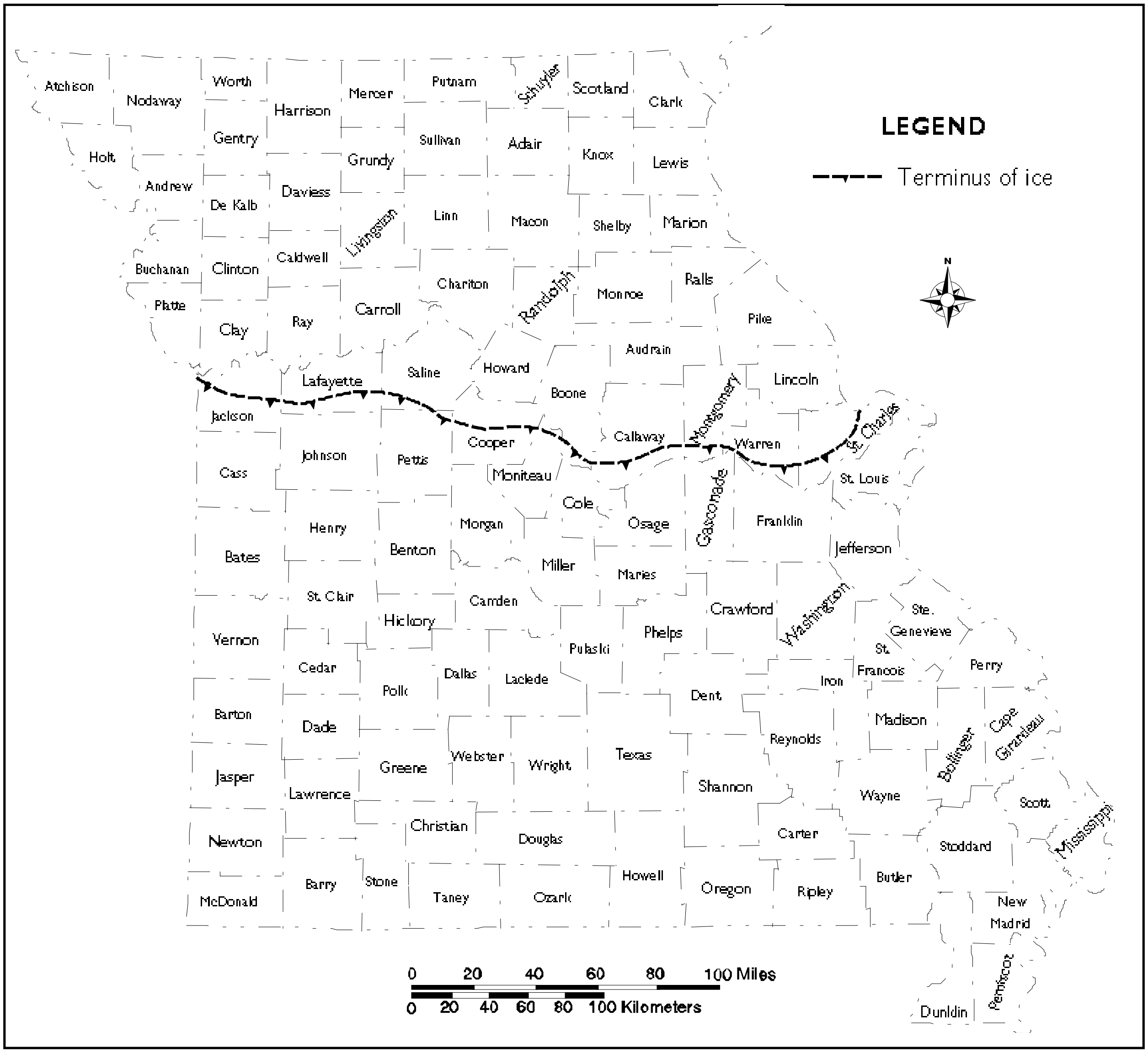


Figure 58. Approximate extent of glacial ice in Missouri.

places along the river there is a series of terrace levels that mark floodplain-remnants remaining after several different phases of downcutting. These downcutting or degradation events probably mark different phases where the regional base level of erosion changed. Underlying some of these terraces are fairly thick sand and gravel deposits that may be saturated with water. There is undoubtedly a hydraulic connection between the groundwater underlying the terraces and the alluvial materials. One such terrace along the Missouri River, which is used as a source of water, deserves mentioning. It is the

Teteseau terrace in northwestern Saline County (Emmett and Jeffery, 1970). This terrace surface is 50 to 60 ft above the present Missouri River floodplain level, and wells producing from it are a source of water for the city of Marshall. The presence of the terrace and its height above the present drainage is probably the result of the blockage of the original channel by glacial ice, and quite probably the terrace developed at the same time that the previously mentioned glacial-age channel traversing Saline County developed. There is a definite need for additional work on river history and the terrace deposits along this reach of the Missouri River.

Presently, there are eleven cities that pump a total of about 15 mgd from the alluvium in this reach (DNR, 1991). Industrial use appears to be limited to the Kansas City area. Emmett and Jeffery (1970) estimate industrial use to be about 13 mgd; more recent data are not available. Numerous irrigation wells are also present, and although pumpage is seasonal and mostly supplemental in nature, pumpage has been approximated to be 1.25 mgd. The total use of alluvial water in this reach of the Missouri River is estimated to be 30 mgd, which is a small percentage of the 1.04 trillion gallons of alluvial aquifer storage estimated for this reach.

Yields of 1,000 to 1,500 gpm are not unusual from production wells drilled through the more permeable zones in the alluvium. These wells have specific capacities of from 50 to 150 gpm per foot of drawdown (Emmett and Jeffery, 1970). Transmissivities range from 150,000 to 250,000 gpd/ft (20,050 to 33,400 ft^2/day).

Like the previously discussed segment of the river, this reach has variable water quality, both spatially and temporally. Total dissolved solids range between 250 mg/L to as high as 1,200 mg/L. In areas of poor circulation due to low permeability, the dissolved solids content of the water is usually higher due to longer residence time of the water in the aquifer. However, the highest levels of mineralization are commonly due to leakage of mineralized water from the bedrock aquifers into the alluvium. As with most groundwater in Missouri, whether it be from bedrock sources or from alluvial sources, calcium and bicarbonate are the most prevalent dissolved constituents. Where there are additions of groundwater from bedrock sources, magnesium and sulfate may be significant. In these instances, sodium and chloride will also be present in varying amounts. As is the case with most alluvial waters, iron and manganese contents are typically high. Water treatment to reduce iron and manganese is necessary for most wells that supply water for municipal or private domestic needs.

MIAMI TO JEFFERSON CITY

The Missouri River from Miami to Jefferson City is 116 miles long, and alluvium in this reach underlies about 291 square miles. In the upstream part of this reach, from Miami to about the southeastern corner of Howard County, the alluvium overlies bedrock formations that contain highly mineralized water. Downstream from here, the bedrock beneath the alluvium contains fresh water with less than 1,000 mg/L total dissolved solids. The bedrock units in the lower part of this reach also tend to have greater permeabilities than those upstream, and probably discharge more water into the alluvium.

Data indicate an average alluvial thickness of approximately 80 ft, with a maximum thickness of about 95 ft. The average saturated thickness is estimated to be 60 ft (Emmett and Jeffery, 1969a). The average thickness of the alluvium in this reach is actually less than it is upstream. This apparent gradual thinning of the alluvial material in a downstream direction is unusual. With most rivers, the thickness of the alluvial materials usually increases in a downstream direction, or remains fairly constant. There is also a significant narrowing of the valley near Glasgow, in Howard County where the valley width narrows from approximately 6.1 miles to just under 2.0 miles in a distance of 10 miles. There also appears to be a slight gradient change downstream from Glasgow. These factors, coupled with the presence of the high terrace upstream, the

abandoned glacial channel in Saline County, and the confluence of the ancestral Missouri (Grand) River just upstream, seem to indicate another major change, which took place in the Missouri River drainage during the latter part of the Ice Age. Based on drillhole information, it appears that an ancestral channel exists that roughly parallels the Missouri River a few miles to the north. This channel starts at the Missouri River between Glasgow and Boonville, and trends east across Boone County north of Columbia, northern Callaway County, and central Montgomery County. Evidence of its existence seems to end near Warrenton in central Warren County. The channel is filled with glacial deposits consisting of sand, gravel, silt, clay and angular fragments of igneous material. A great deal more work will be required to understand the sequence of events that created the drainage changes in this reach of the river, and to accurately delineate the exact location and terminus of this channel.

The lithologic character of the alluvial material in the modern channel of the Missouri River from Miami to Jefferson City is not appreciably different from that upstream, even with all of the apparent changes in drainage due to glaciation. Figure 59 is a cross section of the Missouri River at Boonville, in Cooper County, showing thickness and character of the alluvial deposits.

As with the upstream reaches of the river, only a small percentage of the available groundwater in storage in the alluvium is currently being used. Assuming an average saturated thickness of 60 ft, and an effective porosity of 15 percent, then approximately 546 billion gallons of groundwater is normally in storage. If only 15 percent of the annual rainfall of approximately 38 inches is recharging the alluvial aquifer, this would add a volume of about 88,000 acre-ft or about 79 mgd in this reach. This is the equivalent of 55 wells, each pumping 1,000 gpm, 24 hours a day for 365 days. Emmett and Jeffery (1969) estimated that combined irrigation, municipal, domestic and industrial use (by five cities at the time of the report), was less than 0.45 mgd, or less than 1 percent of the recharge supplied by precipitation alone.

At the time that this estimate was made, the city of Columbia, in Boone County, used groundwater from bedrock wells. Presently, Columbia uses alluvial groundwater from 10 wells located in the McBain Bottoms and also has five auxiliary bedrock wells that bottom in the Potosi Dolomite. The current raw-water supply capacity of the alluvial well field is approximately 16 mgd; 1994 production from the well field averaged about 10 mgd. Aquifer pumping tests show that the transmissivity of the alluvium here is about 440,000 gpd/ft (58,500 ft^2/day), and each well is capable of pumping from 725 to 1,400 gpm. Even with this large usage, the total daily withdrawal from the alluvium in this reach is less than 16.5 mgd, far less than its potential production.

From Rocheport, in western Boone County, to Jefferson City, in northern Cole County, the bedrock units underlying the alluvium contain fresh water, and probably contribute appreciable recharge. Also, groundwater gradients in the shallower bedrock zones are towards the river.

As described in discussion of upstream reaches, incrustation of well screens by excessive calcium carbonate, elevated iron and manganese concentrations, and worry about organic contaminants due to the extreme permeability of the aquifer are the primary water quality concerns.

Total dissolved solids concentration of alluvial water in this reach of the river typically ranges between 250 mg/L and 800 mg/L, with calcium, magnesium, and bicarbonate contributing the largest percentages. In the reach underlain by Pennsylvanian and Mississippian strata, sulfate, sodium, and chloride are present in higher concentrations than in the stretch underlain by Ordovician rock containing fresh water.

JEFFERSON CITY TO ST. CHARLES

The hydrologic characteristics of the Missouri River alluvium in this 147-mile reach are very similar to those in the reach

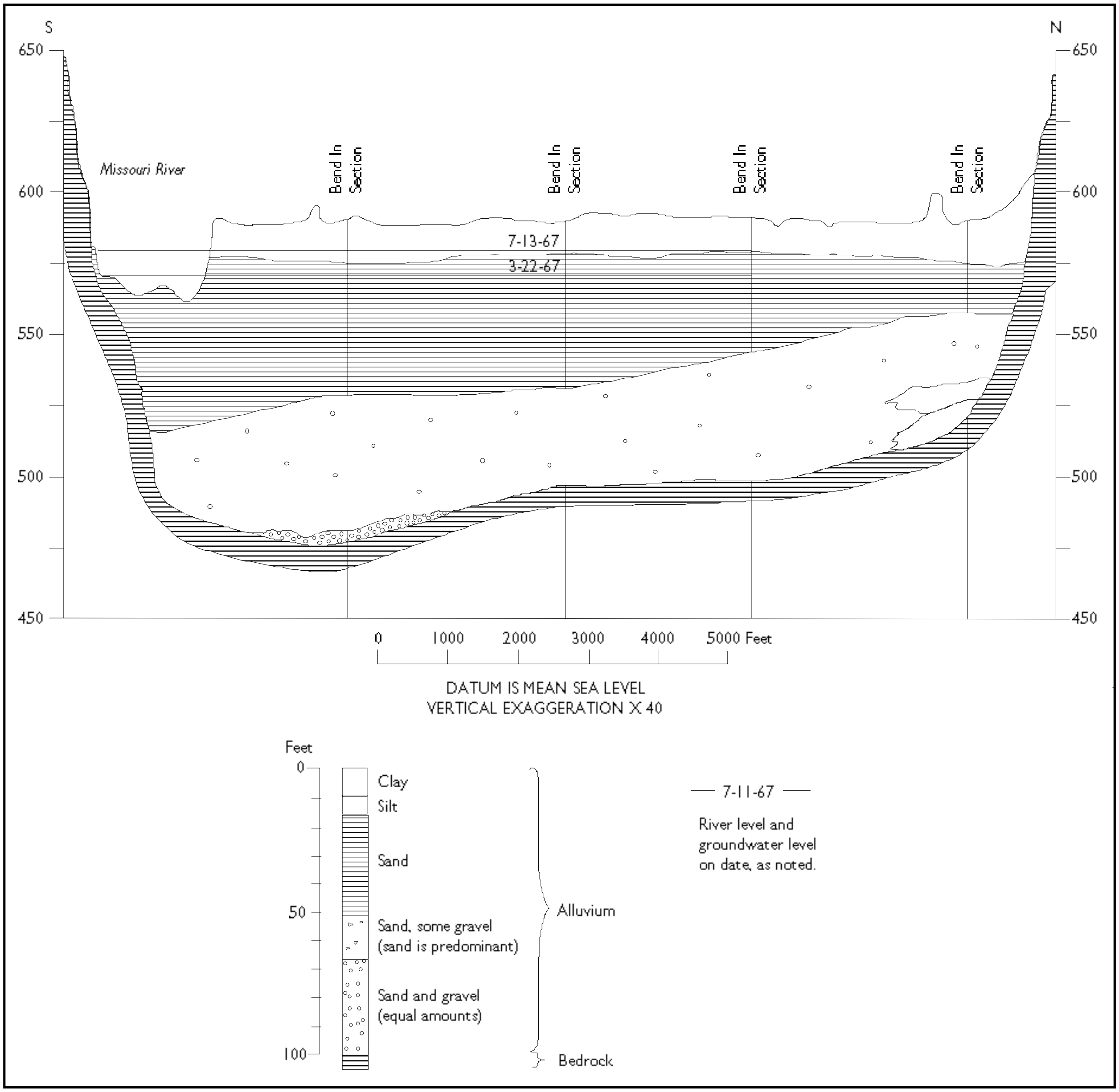


Figure 59. Cross-section of the Missouri River alluvium at Boonville, Missouri (from Emmett and Jeffery, 1969a).

between Miami and Jefferson City. From Jefferson City to northeastern Franklin County, the valley is developed in Ordovician-age bedrock. From northeastern Franklin County to its confluence with the Mississippi River, the valley is developed in Mississippian- and Pennsylvanian-age formations. Currently, the city of St. Charles is the only municipality along this reach of the river that has a well field that uses groundwater from the Missouri River alluvium, but there are numerous water districts, industrial, and irrigation wells in the floodplain adjacent to St. Charles and St. Louis counties.

As with upstream reaches, the deeper part of the alluvium in this reach is composed of coarse sand and gravel, and the upper part grades to finer material near the land surface. The maximum thickness reportedly encountered by drill holes is approximately 120 ft,

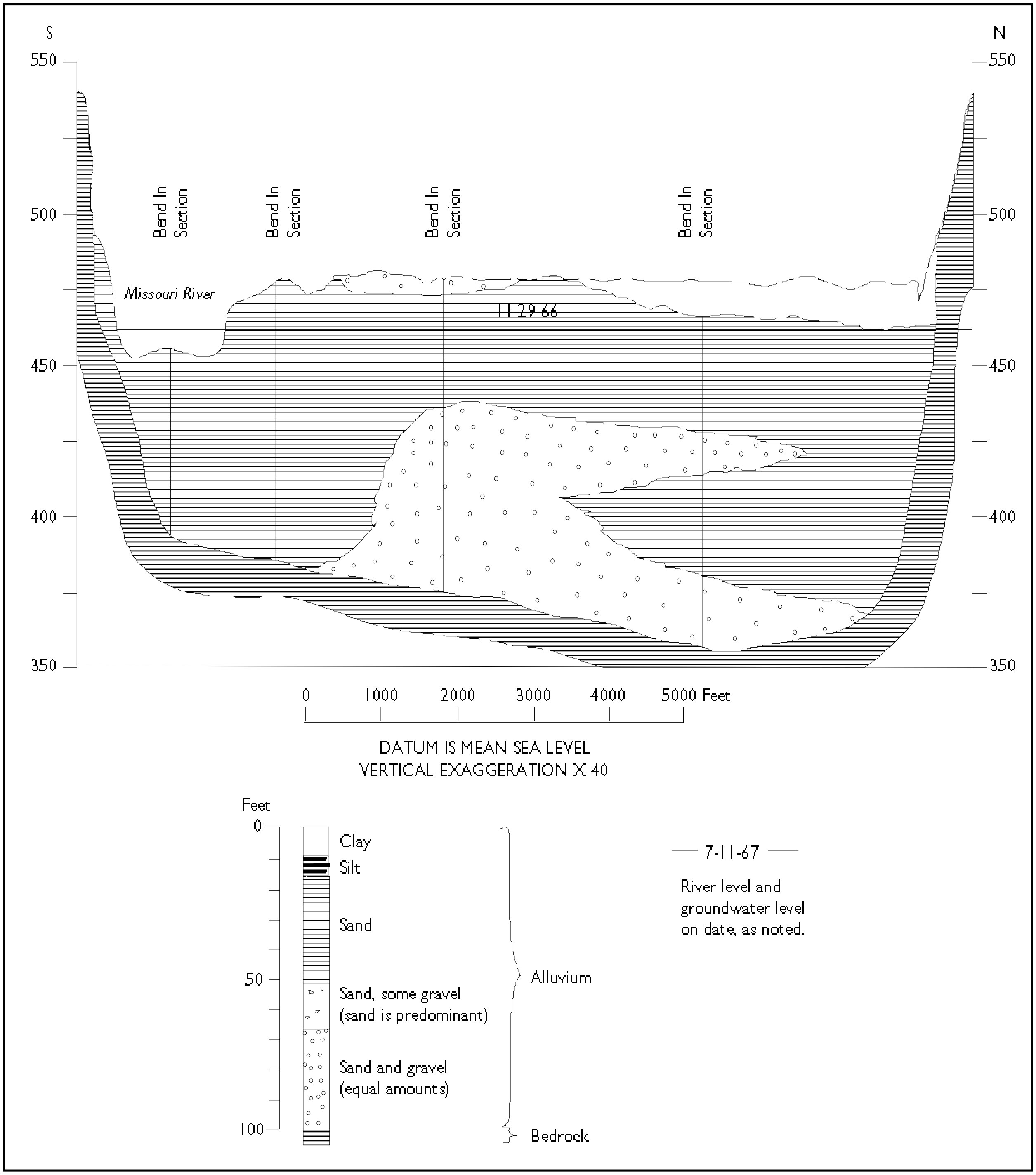


Figure 60. Cross-section of the Missouri River alluvium at Washington, Missouri (from Emmett and Jeffery, 1968).

and the average is 100 ft (Emmett and Jeffery, 1968). Figure 60 is a cross section of the valley at Washington in Franklin County, showing the character and thickness of the alluvial deposits.

As in the upstream reaches, recharge to the alluvium occurs during high river stages, from precipitation, and from bedrock groundwater entering the alluvium. However, leakage from bedrock sources is probably more

important in this reach than in the upstream areas. These formations, although not considered to be the principal or most permeable bedrock aquifers in the Salem Plateau, still yield significant volumes of water to the alluvium when the entire reach is considered.

The alluvial aquifer in this reach of the Missouri River underlies an area of about 224 square miles. Based on an average saturated thickness of 80 ft and an effective porosity of 15 percent, the alluvium contains about 560 billion gallons, or about 1.7 million acre-ft of water. Yields of properly sited and constructed alluvial wells in this area are favorable. Data from an U.S. Geological Survey test drilling program along this reach of the river indicates that in most places the alluvium is capable of yielding 1,000 to 3,000 gpm. Yields of from 2,500 gpm to 3,000 gpm, with transmissivities of 200,000 gpd/ft to 250,000 gpd/ft (26,700 ft^2/day to 33,400 ft^2/day), are not unusual.

The Missouri River alluvium in this reach may, depending on location and river stage, be under either confined or unconfined conditions. The Missouri River alluvium is unconfined where the surficial materials are sandy, or where the clay and silt cap is very thin. Where the clay and silt cap is relatively thick, the aquifer may be under confined conditions. In well fields along the river, the cone of influence from pumping of a high-yield well will generally be shallow, and of a relatively small areal extent. For example, a well producing 2,000 gpm from an aquifer with a transmissivity of 250,000 gpd/ft and a specific yield of 0.15 will create only about 5.7 ft of drawdown in the aquifer a distance of 100 ft from the pumped well after 10 days of continuous pumping. Drawdown in the aquifer adjacent to the well will be only about 15 ft, and 10 ft from the well it will be about 10 ft. In comparison, a high-yield bedrock well in the Salem Plateau pumping 1,000 gpm would likely create more than 100 ft of drawdown at a distance of 100 ft from the well after a few days of pumping.

Although alluvial wells along the Missouri River may be under confined conditions initially, extended pumping will lower the water level to below the base of the confining layer, and the aquifer will then be under water table conditions. Consequently, the storage coefficient of the alluvial aquifer will also change from a relatively small value, typically between 1 x 10^{-3} to 1 x 10^{-5}, to a relatively large value, about 0.15.

Because of the high storage coefficient, it is possible to place several high-yield wells in a relatively small area and still not create substantial drawdown. This is demonstrated at the well fields, that serve the two major public water supply users of alluvial groundwater along this reach of the river.

The well field that once served the Weldon Springs Ordinance Works in southeastern St. Charles County is now used to provide water to numerous rural residents, subdivisions, and other public water supplies in the area. Nine alluvial wells, four of which are very close to the river, have a combined maximum production of about 23,100 gpm, or about 33 mgd. The volume of water produced by St. Charles County Water Department in 1994 was reportedly about 3.62 billion gallons, an average of about 9.93 mgd.

The city of St. Charles and part of rural St. Charles County is supplied from a well field developed in the Missouri River alluvium at the north edge of St. Charles where the floodplains of the Mississippi and Missouri rivers converge. This well field consists of five wells drilled along a north-south line; the wells at the ends of each line are separated by about 2,000 ft, and adjacent wells are from 420 ft to 750 ft apart. All of the wells reportedly yield at least 1,000 gpm, which equates to a maximum potential yield of about 7.2 mgd. In 1994, the city of St. Charles reportedly used 778 million gallons of water, and had an average daily usage of 2.13 mgd.

GROUNDWATER QUALITY

The quality of the alluvial groundwater in this reach of the river is similar to that of the alluvial groundwater in the upstream reaches. It is generally a moderately mineralized calcium-magnesium-bicarbonate type. Iron and manganese generally exceed public drinking water standards by substantial amounts, particularly in those areas where circulation is restricted such as close to the valley walls or where the permeability of the aquifer material is low. In areas where there can be direct interchange or recharge from the river, iron and manganese concentrations are generally lower. Emmett and Jeffery (1968) reported iron to vary between 0.29 and 5.1 mg/L, and manganese to vary from less than 0.05 mg/L to 4.4 mg/L. Total dissolved solids are generally 450 mg/L to 750 mg/L.

Groundwater pumped from bedrock sources in the Ozark and Springfield Plateau provinces requires very little treatment before consumption. In some instances, the water is chlorinated before being pumped into the water mains. The chlorination is sometimes necessary to control the growth of so-called iron bacteria in the mains. These bacteria are sulfate reducers whose by-products include hydrogen sulfide (H_2S) gas and “iron slime.” However, groundwater produced from alluvium generally requires more extensive treatment before it can be used to supply a public water system. The alluvial water is more directly influenced by surface water sources, which increases the risk of bacterial, viral, and other biologic contaminants. Treatment of municipal water supplies commonly includes iron and manganese removal, and some sort of softening, chlorination and retention. The cost of producing 1,000 gallons of alluvial groundwater for municipal use is usually at least twice as high as the same volume of bedrock groundwater.

GROUNDWATER CONTAMINATION POTENTIAL

The potential for groundwater contamination of the alluvial sediments in the Missouri River valley is similar to that of the Bootheel or the Mississippi River alluvium. Where the shallow alluvial materials are sandy and the vertical permeability is relatively high, it is possible for contaminants to rapidly find their way to the water table. This is particularly true of certain pesticides and fertilizers used in agricultural practices. It is also true that pumping of this aquifer will induce recharge from the river; a river whose water quality varies considerably.

Since the alluvial aquifer is so highly vulnerable to contamination, great care must be taken to assure that potential contaminant sources such as landfills, sewage lagoons, chemical storage areas and pipelines do not adversely affect the quality of the alluvial water.

NORTHWESTERN MISSOURI GROUNDWATER PROVINCE

INTRODUCTION

Groundwater resources are much less plentiful in the northern half of Missouri than in the Ozarks and Southeastern Lowlands. The bedrock units that yield large volumes of good quality water in the Salem and Springfield plateaus are also present in the northern part of the state, but are at a much greater depth and, except for the southern part of the Northeastern Missouri groundwater province, generally yield water too highly mineralized for most uses. The most widely used aquifer in the region is glacial drift, which is present throughout much of northern Missouri.

In this report, northern Missouri is divided into the Northwestern Missouri groundwater province and the Northeastern Missouri groundwater province. The dividing line between them is the county boundaries between Schuyler and Putnam, Adair and Sullivan, Macon and Linn, Randolph and Chariton, and Howard and Chariton counties. This division is based more on the availability of data than on changes in hydrogeologic conditions. A test-drilling program conducted in the 1950s in northwestern Missouri helped greatly to characterize the glacial drift and determine its groundwater possibilities. In northeastern Missouri, the glacial sediments are generally thinner and less permeable, and have less groundwater-production potential. However, the bedrock units in some parts of northeast Missouri are more likely to produce potable groundwater than those in the northwest part of the state.

GEOLOGY

Based on the divisions used in this report, the Northwestern Missouri groundwater province consists of 23 counties and covers an area of about 12,117 square miles. Much of the area is covered by thick Pleistocene-age (Ice Age) glacial sediments and recent alluvial deposits. These sediments overlie Pennsylvanian-age and older bedrock formations (table 13). Prior to the onset of glaciation, a mature topography of rolling hills and numerous valleys was developed throughout northern Missouri. There were streams draining surface-water runoff from the area, and surficial materials complete with soil profiles had developed from weathering of Pennsylvanian-age and older bedrock. However, the thick productive soils we know today were not present prior to glaciation.

Ice sheets advanced across northern Missouri at least twice during the Pleistocene, with the maximum southern extent of glaciation roughly paralleling the Missouri River (figure 58). As glaciers advanced across the northern part of the state, they carried a load of boulders, gravel, sand, silt and clay derived en route from areas to the north. The weight of the ice, coupled with the abrasive nature of the transported debris, altered the existing landscape to some extent. When the ice sheets melted and slowly withdrew from Missouri, they left behind deposits of glacial sediments locally thicker than 300 ft. Sediments were mostly deposited from melting continental glaciers at the end of the two ice

System	Series	Group or Formation	Lithology	Hydrology
Quaternary	Recent	Alluvium	Sand and gravel, with interbedded silt and clay deposited by stream action	Yields 30-500 gpm where sufficient thickness of saturated permeabile sand and gravel is present
	Pleistocene	Glacial Till or Drift	Heterogeneous mixture of clay, silt, sand, gravel, and boulder-size material	3-50 gpm available to well where clean, permeable sand and gravel are present
		Preglacial valley fill	Sand and gravel, silt and clay intermixed. Stream-deposited material	Preglacial alluvium may yield as much as 500 gpm where saturated thickness and permeabilities allow
Pennsylvanian	Virgilian	Wabaunsee Group	Shale, siltstone & sandstone	Not considered to be water bearing. Very small quanities of water (1/2-1 gpm) may be obtained locally from the limestone sequences.
		Shawnee Group	Thick limestone formations with intervening shale beds	
		Douglas Group	Dominantly clastic formations. Shale, sandstone & thin limestone	
	Missourian	Pedee Group	A thick sequence of shale with limestone at the top	Small amounts of water (1-3 gpm) locally from thicker limestone formations
		Lansing Group	Two thick limestone sequences separated by shale & sandstone	
		Kansas City Group	Thick limestone formations with intervening shale, some sandstone beds, black, fissile shale in lower part.	Not generally water bearing
		Pleasanton Group	Thick shale sequence with sandstone in lower part. Few thin limestone beds and silt-stones. Scattered coal beds	
	Desmoinesian	Marmaton Group	Shale, limestone, clay and coal beds	
		Cherokee Group	Sandstone, siltstone and shale	Small yields (1-3 gpm) of potable water at depths less than 100 feet in outcrop area.
Units older than Pennsylvanian typically yield highly mineralized water.				

Table 13. Geologic section of the Northwestern Missouri groundwater province.

advances into Missouri. These types of deposits, characteristically, have extremely variable lithologies and thicknesses. In some places, particularly where sediments were deposited in preglacial valleys and channels, the glacial materials are relatively clean, consisting mostly of sand and to a lesser degree gravel. Glacial sediments that were transported by melt water and deposited as stratified materials are often termed stratified drift. In other areas, the deposits are more heterogeneous and non-stratified. This material is commonly called unstratified drift or glacial till. A more general term for all types of glacial deposits is simply glacial drift.

After glaciers retreated at the end of the Ice Age, most of the glaciated terrain exhibited an uneven land surface. Undoubtedly, there were very rugged areas as well as relatively flat areas. Post-glacial erosion and stream action has greatly modified the landscape since the glaciation ended. In some areas, erosion has completely removed the glacial

drift deposits, leaving Pennsylvanian bedrock at the surface.

The preglacial drainage system appears to have been well-developed and extensive. The Grand River, which today traverses the area from northwest to southeast, and enters the Missouri River in southwestern Chariton County, is thought to be the approximate path of the preglacial Missouri River. The movement of glaciers into midwestern North America rerouted the ancestral river, and moved it into its present channel along the northwestern edge of the state. Several other northwest Missouri streams were rerouted or covered by glacial ice. Prior to glaciation, all of these drainages had alluvial deposits underlying their floodplains, with the larger streams having more extensive alluvial deposits than the smaller ones. At the melting of the ice sheets at the end of the Ice Age, these drainage ways were filled with glacial drift or till. While some drainages, such as the ancestral Missouri River/Grand River, were partially reclaimed by later erosion, others have no surface expression that reveals their presence.

HYDROGEOLOGY

Groundwater resources in much of northwest Missouri are poor. The thick carbonate aquifers that supply large quantities of high-quality water in the Ozarks and east-central Missouri are also present at great depth in the northwestern part of the state. In northewst Missouri they yield water so highly mineralized that, for practical purposes, it is unusable. Bedrock formations in the Northwestern Missouri groundwater province older than Pennsylvanian-age yield highly-mineralized water. Usable quantities of groundwater are locally available from Pennsylvanian strata, but yields are typically low and the water quality is marginal. Glacial deposits, depending on thickness and texture, can yield from zero to more than 500 gpm. Except for the Missouri River alluvium, alluvial deposits in northwestern Missouri generally yield small quantities of water. This is because the alluvial sediments of the smaller rivers are finer-grained and more poorly-sorted than those of the Missouri River. However, there are significant exceptions to this, especially near the mouths of major northwest Missouri rivers where the alluvium may yield quantities of water suitable for irrigation or public water supply.

Many years ago, geologists recognized that the stratigraphy and geomorphology of this area are so complex and site specific that it is difficult to predict either the lithologic character or the thickness of material likely to be encountered at any drill site. So, in 1956, using funds provided by the Missouri Legislature, the Missouri Geological Survey (now the Division of Geology and Land Survey) began an ambitious test drilling program to determine the thickness and character of the glacial drift in the Northwestern Missouri groundwater province. The project, which ended in 1960, included 19 of the 23 counties in the province. These drilling studies did much to help northwest Missouri towns and rural residents develop safer, more reliable water supplies. The four northwestern Missouri counties excluded from detailed drilling studies were found not to contain appreciable thicknesses of permeable glacial drift materials. Limited funds prevented their study, as well as a similar study to cover the northeastern part of the state. Table 14 is a listing of county studies available for the area. The studies are a valuable aid to finding and developing water supplies. Groundwater storage estimates for northwest Missouri included with this report rely heavily on the data collected during the 1950s.

PRE-PENNSYLVANIAN AQUIFERS

Mississippian and older sedimentary rock units underlie the exposed Pennsylvanian strata and glacial drift in northwest Missouri. Data from relatively deep test holes, drilled primarily in search of oil, show that groundwater in rock older than Pennsylvanian-age in northwest Missouri is too highly mineralized for most uses. Total dissolved solids of groundwater from deeper bedrock aquifer zones range from about 2,000 mg/L to more than 30,000 mg/L.

WR-15	Andrew County	WR-08	DeKalb County	WR-06	Livingston County
WR-18	Atchison County	WR-07	Gentry County	WR-02	Mercer County
WR-14	Buchanan County	WR-01	Grundy County	WR-16	Nodaway County
WR-13	Carroll County	WR-03	Harrison County	WR-04	Putnam County
WR-12	Chariton County	WR-17	Holt County	WR-10	Sullivan County
*No. 19	Clay County	WR-11	Linn County	WR-05	Worth County
WR-09	Daviess County				

*No. 19 unpublished 1971 & 1972.

Table 14. Listing of county groundwater studies available for the Northwestern Missouri groundwater province.

Pennsylvanian Aquifer

Pennsylvanian-age bedrock consisting of relatively thin limestone, sandstone and shale units with occasional coal seams, underlies essentially all of northwest Missouri. The Pennsylvanian rocks are thinnest along the eastern margin of the province where they are 200 to 300 ft thick, and thicken greatly in the Forest City basin in extreme northwest Missouri where they are as much as 1,800 ft thick. The Pennsylvanian bedrock formations locally contain small amounts of marginally potable groundwater, but only at shallow depths. Despite the great thickness of Pennsylvanian-age rock in northwest Missouri, only the upper 100 to 150 ft potentially can yield potable water. Deeper Pennsylvanian units contain progressively more mineralized groundwater.

All of the Pennsylvanian units are typified by very poor vertical and horizontal permeabilities. Recharge to the Pennsylvanian rock from overlying glacial drift, as well as direct recharge from precipitation in areas where there is no drift, is also very poor. Thus, these deposits are not generally considered to be a viable source of groundwater. In addition, they also contain water which is of marginal quality. If a usable volume of water is encountered at a shallow depth, generally less than 100 to 150 ft, it is far more likely to be of usable quality than groundwater at a greater depth. Locally, a few exceptions exist. For instance, there is an area in southern Clay County where an east-west trending channel sandstone of Pennsylvanian-age has historically yielded 10 to 20 gpm to water wells. This linear, localized formation, which is the Tonganoxie Sandstone Member of the Stranger Formation, was deposited in a relatively narrow trench or valley during Pennsylvanian time. The sandstone is directly overlain by permeable glacial drift. It appears that the overlying drift is providing recharge water to the sandstone from a relatively large recharge area, even though the areal extent of the sandstone is small. Locally, small springs are fed from the sandstone. The small community of Tiffany Springs derives its name from the small spring issuing from between bedding planes in the sandstone near the east end of the channel. Small quantities of crude oil concentrated near the margins of the sandstone body are also associated with the sandstone. Hydrostatic pressure within the sandstone body caused by the relatively constant recharge from the overlying glacial drift has kept the oil from migrating. If hydrologic conditions were to change, then the oil within the

formation boundaries could migrate into existing water wells. Such changes could occur if production of groundwater from the Tonganoxie were to increase to a point where it exceeds recharge, or if major construction such as that associated with large industrial development or highway construction, were to occur in the recharge area.

Table 15 shows groundwater quality in the Pennsylvanian at several locations in northwest Missouri. At best, groundwater in the shallower bedrock zones is marginal in quality, having total dissolved solids that range from 800 mg/L to about 2,000 mg/L. The water can also contain excessive sulfate, chloride, iron and manganese. Its use as a domestic water supply is warranted only because in may parts of the area, such as where the glacial drift is not water-bearing or is absent, there are simply no other options except a cistern or developing a surface-water supply. Water quality worsens with depth. The deeper Pennsylvanian bedrock formations contain groundwater with total dissolved solids that range between 2,000 mg/L and 30,000 mg/L or more.

Glacial Drift Aquifer

The most widespread groundwater resources in northwest Missouri occur in the glacial materials. Depending on thickness, composition, and other factors, the glacial drift can yield from less than a gallon of water per minute, to as much as 500 gpm. Average yield of the glacial drift throughout northwest Missouri is probably less than 5 gpm.

The areas with the highest potential yields are drift-filled preglacial valleys where pre-Pleistocene alluvial deposits were covered with glacial drift. In places, the alluvial deposits found in these preglacial drainage systems yield from 100 to 500 gpm. These preglacial alluvial deposits are, unfortunately, limited in areal extent, and are found in rather narrow linear trends, much the same as modern alluvial valleys. Figure 61 shows the axes of major preglacial valleys known to exist in northwest Missouri. Figure 62 shows the thickness of clean sand found in the glacial drift. Clean sand contains little or no clay or silt, and at least a few feet of it is necessary for a successful small-diameter water-supply well. Drift-filled preglacial valleys can contain more

Well Owner	Well Location				Water Quality															
					Milligrams per liter													Hardness as $CaCo_3$		
	County	Location T R Sec.	Total Depth (Feet)	Date Of Collection	Silica (SO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3 -N)	Dissolved solids (Residue at 180 C)	Calcium, magnesium	Noncarbonate	pH
Ralph Ecklles	Andrew	60N 35W 11	189	06-24-57	6.0	00.3	0.00	76	30	607		416	396	502	1.4	1.4	1,817	315	0	7.6
Rudloph Kruse	Carroll	53N 23W 16	495	05-08-57	6.5	03.4	0.05	322	158	3,324		469	1,073	5,000	1.4	0.1	10,277	392	1,061	7.4
Hugh Swords	Dekalb	58N 30W 28	425	11-20-56	5.3	03.8	0.17	96	47	1,632		452	216	2,348	0.6	6.2	4,589	389	33	8.2
Town of Ridgeway	Harrison	64N 27W 03	1,178	10-20-64	6.0	01.5	0.00	94	30	1,500	35	466	1,704	1,150	1.8	0.0	4,914	356	0	7.3
R. E. Dolan	Linn	58N 21W 05	565	02-05-57	5.5	03.4	0.05	84	46	2,397		418	988	3,060	1.4	0.1	6,787	391	6	7.6
Mercer Public School	Mercer	66N 23W 20	450	01-05-56	6.5	02.7	0.00	41	29	744		1,243	313	278	1.6	0.0	2,011	1,080	0	7.9
John Gaskill	Platte	54N 36W 13	460	04-07-51	4.0	30.0	--	84	40	3,757		347	39	5,747	---	---	9,768	284	89	7.6

Table 15. Groundwater quality data for selected Northwestern Missouri wells producing from Pennsylvanian strata (from Gann and others, 1973).

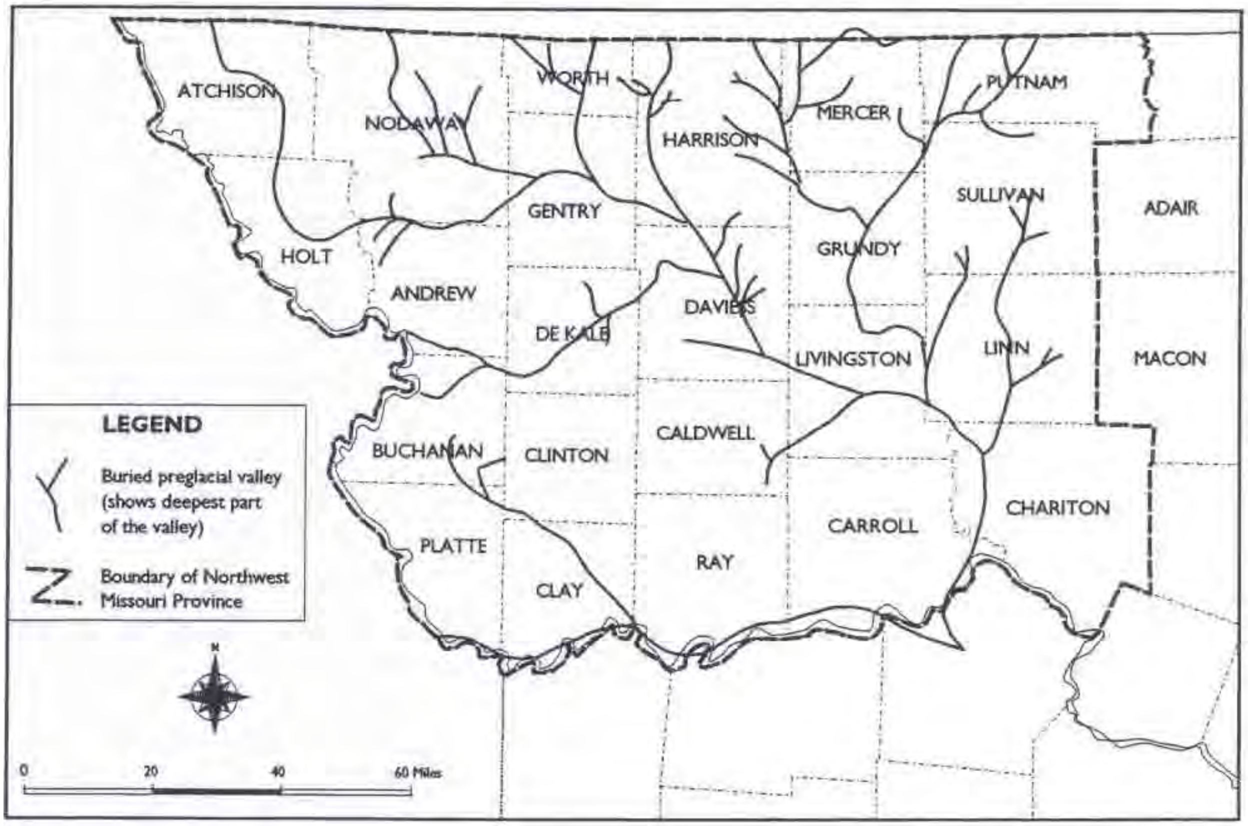


Figure 61. Pre-glacial drainage in the Northwestern Missouri groundwater province (from Gann and others, 1973).

than 100 ft of clean sand and gravel. The data used to produce figure 62 are incomplete because four counties in northwest Missouri were not included in the drilling program of the late 1950s. Supplemental data for these counties obtained from other sources were used in developing the illustration.

Preglacial valleys containing more than 100 ft of clean sand and gravel underlie an area of only about 922 mi^2, or about 7.6 percent of northwest Missouri. Assuming a saturated thickness of 150 ft, and a specific yield of 0.15, water stored in preglacial valleys of northwest Missouri is estimated to be about 4.33 trillion gallons, or about 13.3 million acre-feet.

A considerably larger area of the Northwestern Missouri groundwater province, about 2,786 mi^2 or 23 percent of the province, is underlain by glacial deposits consisting of 25 to 100 ft of clean sand. Water production from these materials is generally much less than from drift-filled preglacial valleys, but yields of 10 to 25 gpm are possible. Based on an assumed saturated thickness of 62.5 ft and a specific yield of 0.1, the volume of water stored in this part of the glacial drift aquifer of the Northwestern Missouri groundwater province is estimated to be about 3.63 trillion gallons, or about 11.1 million acre-feet.

Almost 62 percent of the Northwestern Missouri groundwater province, an area containing about 7,511 mi^2, either contains no glacial drift, or is underlain by drift containing less than 25 ft of clean sand. Assuming a saturated thickness of 12.5 ft and a specific yield of 0.05, there is approximately 0.84 trillion gallons or 2.6 million acre-feet of groundwater in this part of the aquifer.

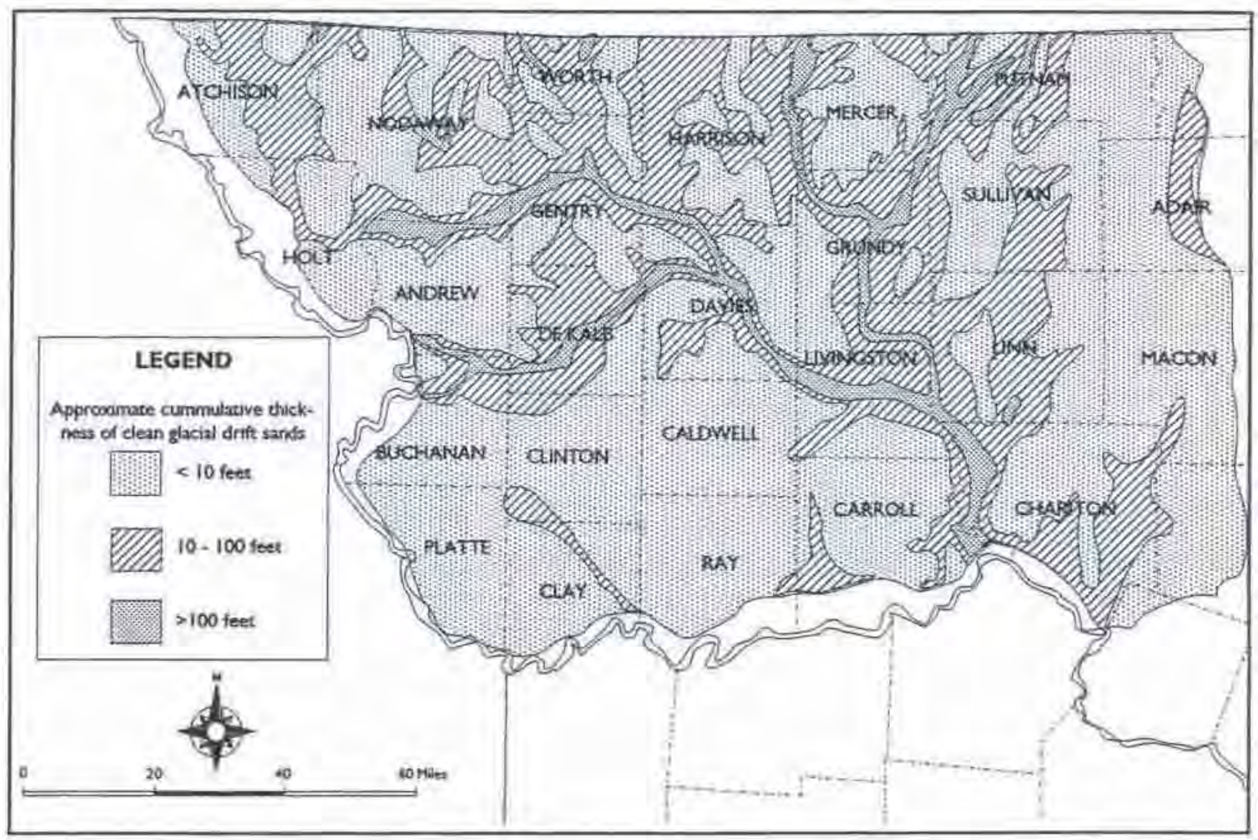


Figure 62. Groundwater possibilities of the glacial drift in the Northwestern Missouri groundwater province (from Gann and others, 1973).

The total volume of groundwater contained in the glacial drift aquifer of the Northwestern Missouri groundwater province is estimated to be 8.80 trillion gallons, or 27 million acre-feet.

The glacial drift of the Northwestern Missouri groundwater province is a complex geologic deposit that can vary in thickness and texture over relatively short distances. It is often necessary to drill several test holes to locate the most water-productive materials at a particular site. It is not unusual to find pockets or lenses of permeable material that are completely surrounded by nearly impermeable clay or silt. The lenses may contain water, but due to limited recharge through the impermeable material, do not have good sustained-yield characteristics. Typically, where the drift is thickest, the probability of encountering sufficient thicknesses of permeable material is best. In many instances, the yield of a well is greatly controlled by the type of well construction used. Yields of conventional wells drilled into glacial drift ranges from a few gallons a minute to 50 gpm, depending on the thickness of clean or permeable sand and gravel. In areas where the thickness or the permeability of the drift is low, large-diameter dug or angered wells are commonly used as water sources. These wells commonly range from two to more than four feet across. Their large diameters provide more inflow area in the permeable zones and increases the storage capacity within the well bore. Their shallow depth and the general lack of effective sealant around the casing or lining makes them more susceptible to contamination than conventional drilled wells.

Overlying the glacial drift, and in some places the Pennsylvanian bedrock formations, is a blanket of silt- and clay-sized material called loess. The loess, which is wind-blown silt, was derived from river floodplains during interglacial periods of the Quaternary. It is usually thickest atop the bluffs and uplands overlooking the major rivers, and thins away from the major river valleys. Being a silt, the loess is moderately permeable. However, since it occupies a high topographic setting, it is typically well drained and generally does not contain appreciable groundwater.

Direction of groundwater flow in the shallow glacial sediments is a factor that is controlled by the present-day surface topography, and the direction of flow in the deeper glacial sediments is controlled, to a great extent, by the preglacial topography impressed on the Pennsylvanian bedrock beneath the drift. Since the character of these deposits is not uniform and permeable, water-bearing zones may be perched or isolated within impermeable zones. Rates of flow within any section of glacial material are generally very slow.

The quality of groundwater contained in glacial drift deposits in northwest Missouri tends to be much better than that in the underlying bedrock, even though recharge and circulation rates are fairly low. Total dissolved solids range between 400 and 1,500 mg/L (Gann and others, 1973). Groundwater quality in the buried, preglacial channels tends to be of poorer quality. This is due to the longer residence time of water in the channel, poor recharge potential, and local leakage of water from adjacent or deeper bedrock formations that contain highly mineralized water.

Recent Alluvium

The Missouri River alluvium, previously addressed in this report, is the most important alluvial aquifer in northwest Missouri. Alluvial deposits beneath the floodplains of other major streams and their tributaries in northwest Missouri tend to be finer-grained and much less permeable than the Missouri River alluvium. In addition, the alluvial sediments also tend to become progressively finer-grained as the distance from the mouth of the river increases, particularly along smaller tributary streams. The reason for this noticeable difference in the texture of the alluvium is the source area for the alluvial material. The alluvial sediments of northwest Missouri stream valleys were derived from the weathering of the glacial drift. Since the shallow glacial sediments are predominately clay, silt and fine sand, the eroded material transported into the tributary streams tends to be fine-grained. The thickness of the alluvial material in the major streams in this region ranges from only a few feet in headwater reaches and along smaller tributary valleys to approximately 60 ft in the southern part of the region. The saturated thickness of the material is somewhat less, ranging from less than 10 ft in the north to about 45 ft in the south.

There are records for relatively few wells or test holes that penetrate the alluvium of most northwest Missouri rivers. In general, the most favorable alluvial deposits appear to be those of the lower parts of the Grand and Chariton rivers. The Chariton River alluvium along its lower reach is known to be a good aquifer. In 1980, the city of Salisbury in Chariton County abandoned its former alluvial well supply on the Middle Fork of the Chariton River east of the town, and developed a new well field in the Chariton River alluvium about 4 miles to the west. Aside from developing a surface-water supply, the only other feasible long-term alternative was to develop a well field in the Missouri River alluvium that would have required at least 10 to 12 miles of pipeline. A 24-hour pumping test of the first Salisbury production well drilled in the Chariton River alluvium showed that it was capable of yielding more than 400 gpm. Drawdowns measured at five observation wells showed the transmissivity of the alluvium to be about 34,000 gpd/ft (4,550 ft^2/day), and its storage coefficient to range between about 1.6×10^{-3} and 3×10^{-4}. The city subsequently installed three production wells that have performed quite well for the past 16 years.

Existing information is not adequate to establish the water-producing characteristics of the alluvial deposits of most northwest Missouri streams, or accurately estimate the volume of groundwater stored in the deposits. The Grand, Thompson, Chariton, Platte and Nodaway rivers are known to have sufficient alluvial deposits to yield at least 50 gpm. Test drilling would be necessary to determine if other streams had similar potential. Figure 63 shows the major alluvial deposits of the Northwestern Missouri groundwater province. The volume of groundwater stored in alluvium along these rivers is conservatively estimated to be about 385 billion gallons, or about 1.2 million acre-ft, but could easily be several times more.

The chemistry of the groundwater in the alluvial deposits along the major rivers and tributaries of northwest Missouri is similar to the chemistry of water from the alluvium of the Missouri River. However, iron and manganese levels tend to be even higher in the alluvium of the Missouri River tributaries, ranging between 0.4 mg/L to 18.0 mg/L for iron, and 0.3 mg/L to 1.8 mg/L for manganese, with the averages being 5.0 mg/L and 0.35 mg/L respectively. Total dissolved solids range from a low of 230 mg/L to a high of approximately 850 mg/L (Gann and others, 1973).

GROUNDWATER CONTAMINATION POTENTIAL

In the Northwestern Missouri groundwater province, groundwater recharge rates and groundwater velocities are relatively low, both in the unconsolidated and bedrock aquifers. Groundwater contamination is possible, and numerous cases of groundwater pollution have been documented. However, most are local problems caused by private septic systems, agricultural runoff from livestock con-

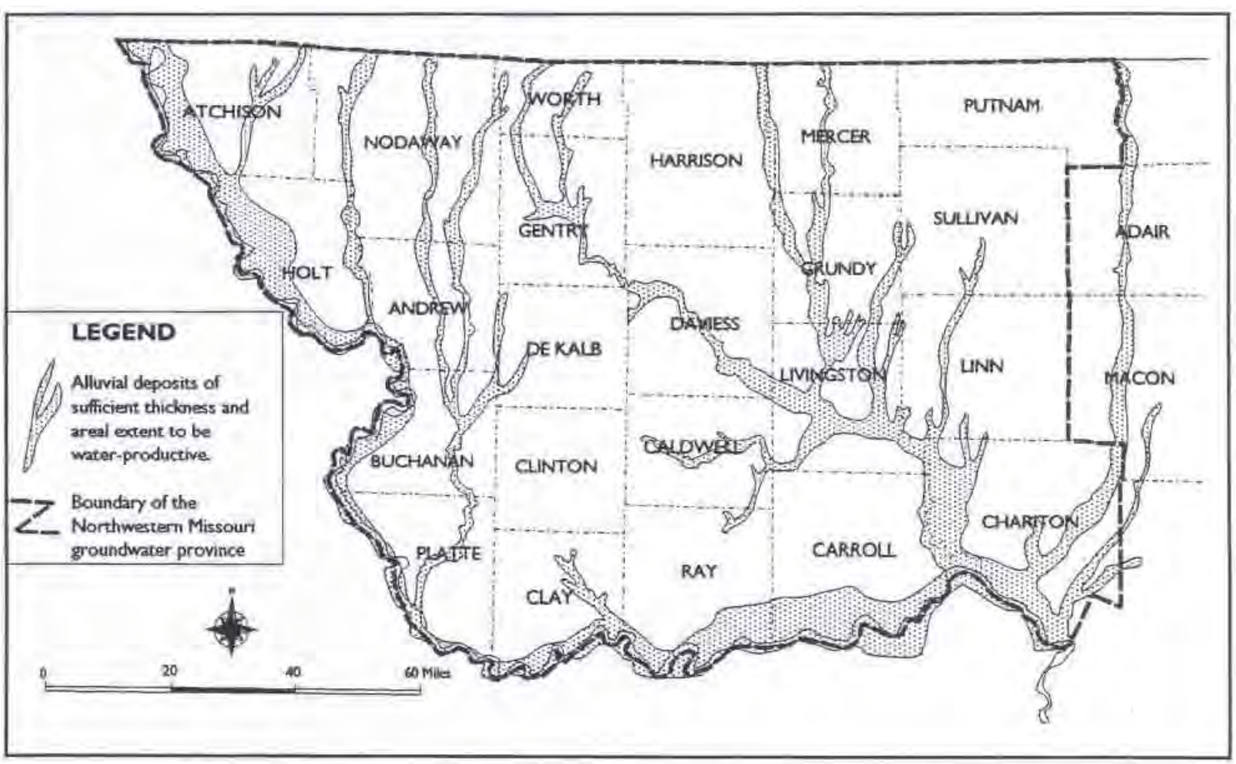


Figure 63. Major alluvial deposits in the Northwestern Missouri groundwater province (from Gann and others, 1973).

finements, fertilizer, and other agricultural chemicals such as pesticides and herbicides.

Municipal wastewater stabilization lagoons are also local risks to groundwater resources. Any waste-disposal facility should be carefully sited. Even though water resources are meager in much of the region, glacial drift water is often all that is available for rural use.

The wells at greatest risk to groundwater contamination are shallow wells in the upper part of the glacial drift. Prior to the availability of modern drilling machines, these shallow glacial drift wells were dug by hand. They are generally less than 30 ft deep, 3 to 6 ft in diameter, and typically lined with field stones or brick. These wells were and are still used in areas where the glacial drift contains little clean sand and production is low. Their large diameters allow them to collect and store a substantial volume of water, despite a low inflow rate. However, these wells are difficult to seal, and are open to very shallow horizons. Thus, they routinely contain bacteria and, where affected by agricultural runoff, may contain excessive nitrate and agricultural chemicals. The modern equivalent of the hand-dug well is drilled with a large auger or bucket-type drilling rig. The new wells can be cased with tile or concrete casing that can be more effectively sealed, which helps reduce the chances of shallow contaminants entering the well bore. Properly constructed drilled wells that are cased with steel or plastic casing and produce from deeper horizons in thick drift deposits are not normally affected by shallow contaminants.

NORTHEASTERN MISSOURI GROUNDWATER PROVINCE

INTRODUCTION

This province includes all or parts of 21 counties, and encompasses an area of about 11,708 mi^2. It is bounded to the north by the Missouri-Iowa border, on the east by the Mississippi River, on the south by the Missouri River, on the west by the Northwestern Missouri groundwater province.

This area shares several geologic similarities with the Northwestern Missouri groundwater province. It contains glacial drift deposits that are underlain by Pennsylvanian and older bedrock. However, groundwater conditions in the Northeastern Missouri groundwater province are considerably more diverse than those in northwest Missouri. Because of this diversity, northeastern Missouri is probably the most difficult of the groundwater provinces to accurately characterize.

In the northern and western part of the Northeastern Missouri groundwater province, the glacial drift is moderately thick, but generally has a very low permeability. It normally can supply water only in small quantities. It is underlain by Pennsylvanian strata which, like strata in northwest Missouri, generally yield only small quantities of poor quality water. The eastern part of the province also contains glacial drift, but it is generally thinner than to the north and west. Here, the drift is directly underlain by Mississippian-age bedrock that, in its upper part, can yield moderate quantities of potable water. Farther to the south along the Mississippi River, uplift along the Lincoln Fold has brought older, early Mississippian, Devonian, and Ordovician rocks to the surface. Yields and water quality vary greatly in these deposits. The southern part of the province, from northern Audrain County to the Missouri River, is also underlain by glacial drift, but here it is of little importance as an aquifer. The freshwater-salinewater transition zone crosses the province along northern Audrain County, and south of the transition zone aquifers in Mississippian, Ordovician, and Cambrian bedrock units yield large quantities of good quality water.

GEOLOGY

Bedrock units underlying the Northeastern Missouri groundwater province that are hydrologically significant range in age from Cambrian to Pennsylvanian (table 16). The lithologies of most of these geologic units have been discussed in other sections of the report, and will not be described in detail here. The Cambrian strata that form the St. Francois aquifer in the Ozarks are present at considerable depth in northeast Missouri, and south of the freshwater-salinewater transition zone are likely to contain potable water. However, they are not known to be currently used in this area. The Davis Formation, which forms the St. Francois aquifer confining unit to the south, is also present and serves the same hydrologic function in northeast Missouri that it does in the Ozarks—it hydrologically separates the shallower water-bearing strata above the Davis from the deeper Bonneterre Formation and Lamotte Sandstone. The clastic part

System	Series	Group or Formation	Lithology	Hydrology
Quaternary	Recent	Alluvium	Clay, silt, sand and gravel. Stream deposits	Yields 25 to 100 gpm where there is sufficient thickness of "clean" saturated sand and gravel.
	Pleistocene	Glacial Till or Drift	Silty, clay, sand, gravel and boulders. May be bedded or indeterminant mixture. Deposited by melting glaciers.	Yields 5 to 275 gpm are possible where sufficient thickness of "clean" saturated sand and gravel is present.
Pennsylvanian	Missourian	Pleasanton Group	Dominantly clastic sediments. Shale, siltstone and scattered sandstone beds	Not water bearing except where sandstone channels occur, then yields of 3 to 4 gpm are possible.
	Desmoinesian	Marmaton Group	Shale, limestone, clay and coal beds	Not utilized as a source of groundwater in this province.
		Cherokee Group	Sandstone, siltstone, shale, underclay, coal and thin limestone beds. Recognizable cyclic sequences	
		Krebs Subgroup	Sandstone, siltstone, shale, clay, thin limestones. Some coal beds in shale sequences. Beds of conglomerate locally.	
Mississippian	Meramecian	Ste. Genevieve Limestone St. Louis Limestone	Fine- to medium-crystalline limestone and shale	May yield 5-10 gpm where units are not deeply buried. Water is mineralized when found below 300 feet.
		Salem Formation	Buff-colored limestone, dolomitic limestone and shale	
		Warsaw Formation	Fine- to coarsely-crystalline limestone	
	Osagean	Keokuk Limestone	Bluish gray, medium- to coarsely-crystalline, medium-bedded lime stone. Abundant light-gray chert.	May yield 10-15 gpm of potable water near the outcrop line. Water is mineralized where formation is deeply buried.
		Burlington Limestone	White to tan, coarsely-crystalline, fossiliferous limestone with layered chert nodules.	
	Rock units below the base of the Burlington Limestone contain mineralized water north of freshwater/salinewater transition zone.			
	Kinderhookian	Sedalia Limestone Chouteau Limestone	Limestone, dolomite, and shale	
		Hannibal Shale	Shale	Confining layer throughout much of northern Missouri, thinning to the south.
Devonian	Upper	Louisiana Limestone Grassy Creek Shale Snyder Creek Shale	Shale and limestone	
	Middle	Cedar Valley Limestone	Limestone	Unimportant as an aquifer.
	Lower			
Silurian		Bowling Green Dolomite	Limestone and dolomite	

Table 16. Stratigraphic section of the Northeastern Missouri groundwater province. (Modified from Imes, 1985.)

Table 16 continued

System	Series	Group or Formation	Lithology	Hydrology
Ordovician	Cincinnatian	Maquoketa Shale	Shale	Confining layer in extreme east along Mississippi River.
	Mohawkian	Kimmswick Limestone	Dolomite and limestone	Yields generally sufficient for domestic supplies. 5-10 gpm.
		Decorah Group Plattin Limestone Joachim Dolomite	Dolomite, limestone and shale	Limited source of water. Locally may be confining layers.
	Whiterockian	St. Peter Sandstone	Sandstone and dolomite	Good production for domestic, farm and small industry. Excessively mineralized in the north. 25-75 gpm.
Ordovician	Canadian	"Powell" Dolomite Cotter Dolomite Jefferson City Dolomite	Dolomite	Unimportant as an aquifer, but may produce sufficient water locally for domestic and farm use. 0-25 gpm.
		Roubidoux Formation	Sandstone and dolomite	Good producer. Commonly sufficient for municipal, industrial and irrigation water supplies. 50-500 gpm.
		Gasconade Dolomite Gunter Sandstone Mbr.	Dolomite and sandstone	
		Eminence Dolomite Potosi Dolomite	Dolomite	Excellent producer. Capable of large yields for large cities, industry and irrigation. 440-1,100 gpm.
Cambrian	Croixian	Derby-Doe Run Dolomites Davis Formation	Shale and dolomite	Limited source of water. Confining layer in northern Missouri.
		Bonneterre Dolomite Lamotte Sandstone	Sandstone and dolomite	Little information available. Probably some production from the Lamotte sandstone.
Precambrian			Igneous rocks	Unimportant as a source of water.

of this sequence, which includes the Lamotte Sandstone in most of the province, and the Mt. Simon Sandstone in the northeast corner of the state, thickens from about 100 ft in the western part of the province to about 450 ft along the Mississippi River, but thins somewhat across the Lincoln Fold.

As in the Ozarks, the Davis is overlain by a thick sequence of Upper Cambrian and Ordovician formations that comprise the most significant bedrock aquifer in northeast Missouri. These include, in ascending order, the Derby-Doerun Dolomite, Potosi Dolomite and Eminence Dolomite, all of Cambrian age, and the Gasconade Dolomite, Roubidoux Formation, Jefferson City Dolomite, Cotter Dolomite, "Powell" Dolomite, Everton Formation, St. Peter Sandstone, Joachim Dolomite, Plattin Limestone, Decorah Group, and Kimmswick Limestone, all of Ordovician age. These units have a combined thickness that varies from about 900 ft in northeast Callaway County, to about 1,800 ft in central St. Charles County. Average thickness across most of the area of these units is about 1,300 ft.

The Maquoketa Shale is present in the eastern and southeastern part of the province where it can be as much as 140 ft thick. Silurian- and Devonian-age strata, including the Louisiana Limestone, Grassy Creek Shale, Saverton Shale, Snyder Creek Shale, and several other units are found in northeast Missouri. The combined thickness of these units range in thickness from zero in their outcrop areas

along the southern margin of the province and along the Lincoln Fold, to a maximum of about 320 ft in the northwestern corner of the province.

Many of the Mississippian-age formations that comprise the Springfield Plateau aquifer in southwest Missouri are also present in northeast Missouri. However, there are several other formations present in northeast Missouri that are not found in the southwestern part of the state. The lowermost Mississippian unit is the Hannibal Shale in the Kinderhookian Series. It is overlain by the Chouteau Group (undifferentiated) and Sedalia Formation, a predominately limestone sequence. Osagean Series formations include the Fern Glen, Burlington, and Keokuk limestones. These are overlain by Meramecian Series units that include, in ascending order, the Warsaw, Salem, St. Louis, and Ste. Genevieve limestones. As their names indicate, most of the Mississippian-age formations are predominately limestone units. The thickness of the Mississippian-age rock units vary greatly in the province. The Mississippian units are missing where they have been removed by erosion along the Lincoln Fold, and in the southern part of the province where older rock units form the bedrock surface. They generally increase in thickness to the northwest to a maximum of about 500 ft in Schuyler County, and to the southeast in extreme eastern St. Charles County to about 900 ft. Throughout most of the province, they average between 200 and 400 ft thick.

The western and most of the southern part of the province are underlain by bedrock of Pennsylvanian-age. These units are predominately fine-grained clastics and thin limestones interspersed with numerous coal seams. The formations are mostly in the Desmoinesian and Missourian Series, and include formations in the Krebs Subgroup, Cherokee Group, Marmaton Group, and Pleasanton Group. Total thickness of the Pennsylvanian sediments range from zero, where they have been removed by erosion at the edge of their outcrop belts along the Missouri River, to a maximum of about 300 ft in western Adair County. The Pennsylvanian strata are missing in a large area of the eastern part of the province, mostly across the Lincoln Fold, but also to the north and west of it. In these areas, glacial drift directly overlies Mississippian-age and older strata.

There is a linear, east-west trending, geologically ancient channel eroded into Pennsylvanian rocks that trends easterly from southeastern Chariton County, through central Randolph County (including Moberly), and ends in east-central Monroe County. This channel, which is about 40 miles long and varies from less than one to as much as six miles wide, is filled with Pennsylvanian-age sandstone that is locally as much as 150 ft thick. This unit is stratigraphically equivalent to the Warrensburg Sandstone Member of the Pleasanton Formation to the southwest, but in northeast Missouri it is referred to as the Moberly Sandstone.

Like in northwest Missouri, glacial sediments of Pleistocene age overlie the bedrock formations throughout much of this province. These include glacial drift and loess, which range in thickness from 50 feet or less in the southern and southeastern part of the province to more than 300 feet in the extreme northwestern part (figure 64). In particular, the drift in the northern part of the northeast Missouri province has a greater percentage of coarse sand and gravel than that further to the south. However, despite the greater percentage of coarse clastics, most of the glacial drift deposits do not seem to be well sorted in zones. With few exceptions, the deposits are interspersed with clay and silt, leaving very little clean sand or gravel. The lithologic character of the glacial drift in northeastern Missouri is quite similar to that of the drift of northwestern Missouri. It consists mostly of clay and silt with lesser amounts of sand. It is probable that, like drift in the northwestern part of the state, it is a combination of material from multiple advances of the ice sheets into northern Missouri during both the Nebraskan and Kansan stages. This is undoubtedly true for the drift in the northern parts of both the Northwestern Missouri and Northeastern

Missouri groundwater provinces, where the drift is thickest. In many areas where drillhole information is available, geologists have observed weathered intervals within the drift, which show the development, or partial development, of an ancient soil zone. Ancient soil zones, termed paleosols or geosols, indicate major breaks in deposition that allow the newly deposited materials to be exposed to weathering.

Unlike the Northwestern Missouri groundwater province, where an extensive test-hole drilling program in the 1950s and 1960s characterized the glacial drift, the glacial deposits in northeast Missouri have never been explored through a detailed drilling program. Most of the information concerning the geologic and hydrologic characteristics of the glacial drift in the Northeast Missouri groundwater province is the result of water well

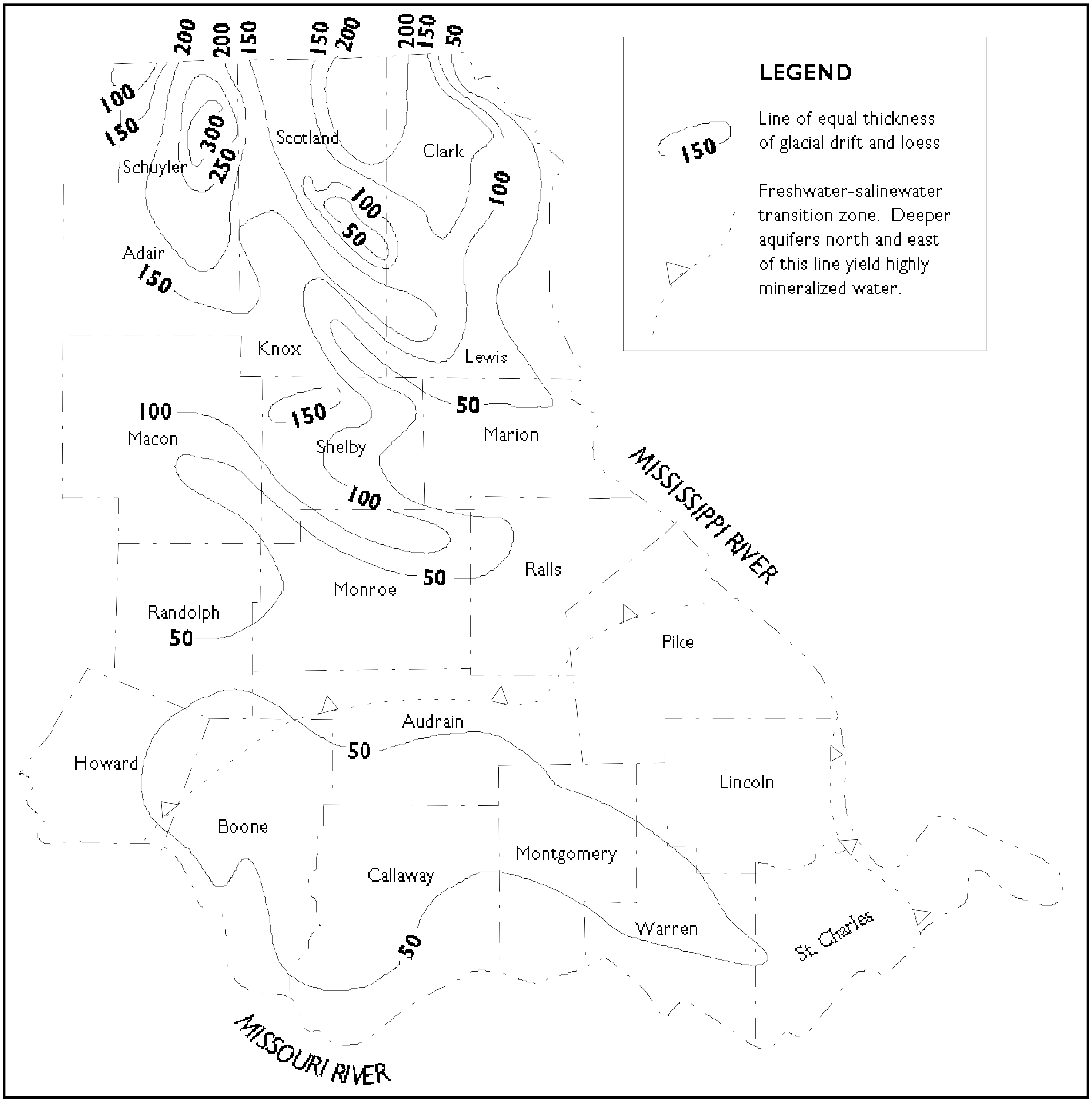


Figure 64. Thickness of glacial drift and loess in the Northeastern Missouri groundwater province (modified from Gann and others, 1971).

drillers submitting samples of well cuttings that were collected while wells were being drilled. The cuttings were subsequently examined by geologists at the Division of Geology and Land Survey and its predecessor, the Missouri Geological Survey. However, the vast majority of the glacial drift wells were hand dug several generations ago, and no information exists for most of them. Since the Northeastern Missouri groundwater province never received an extensive drilling program, there are little data to show the locations of preglacial drainage, or drift-filled channels, or even where the drift is more suitable for well development. A great deal more study is needed in dating and typifying the drift deposits to determine age, lithology and water-bearing character of the individual units.

HYDROGEOLOGY

Approximately the northern two-thirds of this province lies north of the freshwater-salinewater transition zone, which trends through western and northern Boone County, northern Audrain County, and central Pike County. South of the transition zone, wells drilled into the Mississippian-age rock generally yield enough water for domestic and farm purposes while wells penetrating the Ordovician and Upper Cambrian strata can yield quantities of water ample for irrigation, municipal and rural public water supply. North of the transition zone, the deeper bedrock water is highly mineralized, and without extensive treatment be used for potable water supply. Modest quantities of water can be produced from the Mississippian- and Pennsylvanian-age rock and the glacial drift, but water quality is generally marginal to poor. Up to a few miles north of the transition zone, the St. Peter Sandstone can yield potable water.

CAMBRIAN-ORDOVICIAN AQUIFER

The same bedrock units that comprise the Ozark aquifer in the Salem and Springfield plateaus are present in northeast Missouri, and also form its most significant bedrock aquifer. However, in this province it is referred to as the Cambrian-Ordovician aquifer, and it includes the bedrock sequence from the top of the Kimmswick Limestone to the base of the Derby-Doerun Dolomite. The reason for the different aquifer name is that it is not part of the Ozark aquifer flow system. The Ozark aquifer is recharged from precipitation in the Salem Plateau. Groundwater moves radially from the center of the Ozark Uplift, and at the northern boundary of the aquifer discharges into the Missouri River. The Cambrian-Ordovician aquifer appears to be recharged from north of the Missouri River. Imes (1985), using water-level data collected from wells drilled both for water supply and oil exploration, determined that there are two nearly independent flow systems within the Cambrian-Ordovician aquifer in north central and northeast Missouri. Potentiometric data shows saline water entering Missouri from the northwest. There is a groundwater divide in the vicinity of Linn, Chariton and Macon counties; part of the salinewater flows to the east beneath the Mississippi River into Illinois north of Lincoln County, and part flows to the south and discharges into the Missouri River in southern Chariton and Howard counties.

A local freshwater flow system is present in the southern part of the province in Boone, Audrain, southern Pike, Lincoln, St. Charles, Warren, Montgomery and Callaway counties. This freshwater flow system is recharged principally by downward movement of groundwater from the overlying Mississippian strata in southwestern Audrain and northern Warren counties, and by precipitation infiltration where the aquifer crops out along the southern margin of the province and atop the southern end of the Lincoln Fold (Imes, 1985).

The thickness of the Cambrian-Ordovician aquifer in the province, which includes the bedrock units between the base of the Maquoketa Shale and the top of the Davis Formation, varies from about 900 ft in northwest Callaway County to about 1,800 ft in central St. Charles County. Significant water-yielding units in the aquifer include the St. Peter Sandstone, Roubidoux Formation, lower Gasconade Dolomite, Gunter Sandstone Member, Eminence Dolomite, and Potosi

Dolomite. The part of the aquifer comprised by the Jefferson City, Cotter and "Powell" dolomites will yield enough water to provide for farm and domestic use, but typically not enough for high-yield demands. The Joachim Dolomite, Plattin Limestone, and Decorah Group yield little water, and probably serve as local aquitards, but the overlying Kimmswick Limestone can yield enough water for domestic water supply.

Wells fully penetrating the Cambrian-Ordovician aquifer in the freshwater area can yield from 300 to more than 1,000 gpm. Short term pumping tests of these wells show that transmissivity of the aquifer varies greatly with respect to geographic location and the part of the aquifer open to the well. Values of from 3,500 gpd/ft (467 ft^2/day) to more than 10,000 gpd/ft (1,337 ft^2/day) have been calculated from pumping test data.

Regional groundwater modeling by Imes (1985) indicates that transmissivity of the freshwater part of the aquifer ranges from about 2,000 gpd/ft (267 ft^2/day) to about 7,000 gpd/ft (935 ft^2/day). Groundwater storage estimates indicate that the freshwater part of the Cambrian-Ordovician aquifer contains about 60.3 trillion gallons, or about 185 million acre-ft of water in storage.

Water quality is very poor in the Cambrian-Ordovician aquifer on the salinewater side of the freshwater-salinewater transition zone where total dissolved solids can exceed 10,000 mg/L. Throughout the freshwater part of the aquifer, dissolved solids are generally less than 1,000 mg/L. On the freshwater side, the water is a moderately mineralized calcium-magnesium-bicarbonate type. Sulfate and chloride are each typically below 250 mg/L. In the salinewater zones, the water is generally a sodium chloride type. Chloride can exceed 5,000 mg/L and sulfate can be more than 1,000 mg/L.

Mississippian-Devonian-Silurian Confining Unit

A thick sequence of low-permeability sedimentary rocks greatly impedes the exchange of water between the Cambrian-Ordovician aquifer and the shallower Mississippian aquifer. This aquitard is composed of several Lower Mississippian, Devonian and Silurian formations. The least permeable units include the Hannibal (or Kinderhook) Shale, Bachelor Formation, Grassy Creek Shale and Snyder Creek Shale. These strata are as much as 300 ft thick in extreme northeastern Missouri, and thin to a few feet or less in the southern counties of the province. These units are absent across the crest of the Lincoln Fold; here, the middle Ordovician Maquoketa Shale serves as the upper confining unit of the Cambrian-Ordovician aquifer.

Mississippian aquifer

Water-productive horizons in Mississippian strata can supply modest quantities of usable quality groundwater in some of the eastern and southern parts of the the Northeastern Missouri groundwater province. North of the freshwater-salinewater transition zone, those areas where the Pennsylvanian strata are thin or missing, and the glacial drift is relatively thin, have the best potential for yielding potable water. The most productive water-bearing zones are the Burlington-Keokuk limestones, and to a lesser extent the Sedalia and Chouteau limestones. Wells designed to take advantage of this aquifer should not be drilled any deeper than necessary. If a usable quantity of satisfactory quality water is not encountered in the upper 50 ft or so of the Mississippian strata, then it probably will not be found. Yields typically range from 5 to 15 gpm. Yields are generally less where the upper part of the Mississippian consists of Ste. Genevieve, St. Louis, and Salem limestones or Warsaw Formation. These units are typically less permeable than Burlington-Keokuk. Figure 65 shows the approximate area where Mississippian-age rock subcrops beneath the glacial drift.

South of the freshwater-salinewater transition zone, the Mississippian strata generally yields good-quality water. Yields increase somewhat since wells can take advantage of the full saturated thickness of the Mississippian strata and not just the upper part of it. Still,

yields of less than 15 gpm are still a realistic expectation.

It is difficult to estimate the volume of potable water available from the Mississippian aquifer in this province. Storage estimates north of the freshwater-salinewater transition zone assume that potable water is available from only that part of the Mississippian that subcrops directly below the glacial drift, that only the upper 50 ft of the Mississippian contains potable water, and that the specific yield of the aquifer is 0.05. Storage estimates for counties south of the transition zone assume that the full saturated thickness of the Mississippian contains potable water, and that the specific yield of the aquifer is 0.05. Based on these assumptions, the Mississippian aquifer in the Northeastern Missouri groundwater province contains about 6.04 trillion gallons, or about 18.5 million acre-ft, of potable groundwater. Twenty-five percent of this, 1.52 trillion gallons or 4.67 million acre-ft, is

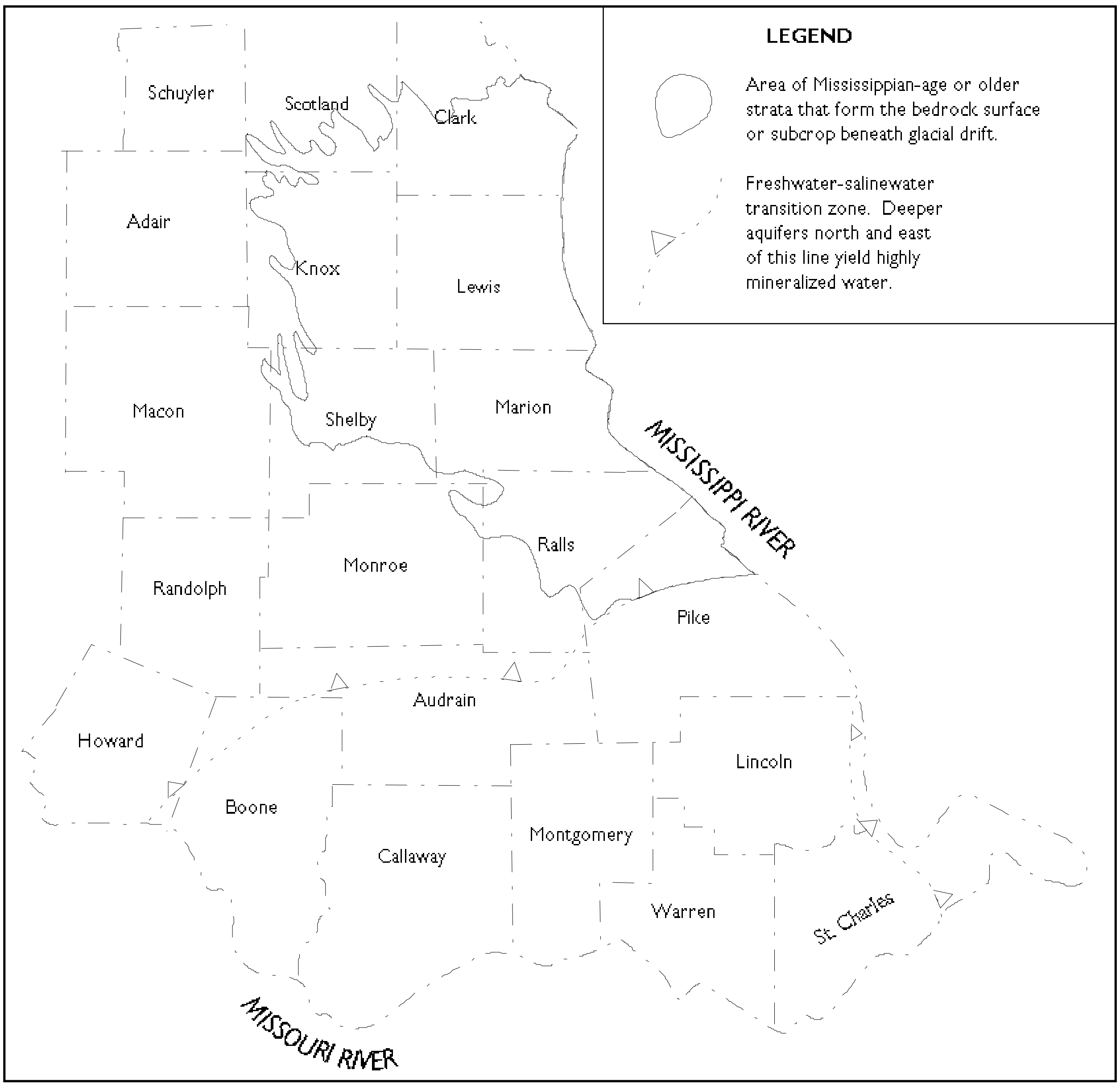


Figure 65. Area in northeast Missouri where Mississippian-age or older strata form the bedrock surface or subcrop beneath glacial drift.

contained in the aquifer north of the freshwater-salinewater transition zone, and the remaining 75 percent, 4.52 trillion gallons or 13.9 million acre-ft, is stored south of the transition zone.

A potentiometric map constructed by Imes (1985) shows a major groundwater divide in the Mississippian aquifer that extends from the Iowa line through central and eastern Schuyler and Adair counties, western Knox, Shelby, Monroe, Audrain and Callaway counties. West of the divide, groundwater in the Mississippian aquifer moves to the southwest toward the Missouri River. East of the divide, movement is toward the Mississippi River in the northern area and toward the Salt River in southern Shelby, Monroe, Ralls and northern Audrain counties. Mississippian aquifer water southwest of a groundwater high in southwest Audrain County flows toward the Missouri River. To the northeast and southeast of the high, groundwater in the Mississippian aquifer moves toward the Salt River, or toward the Missouri River. A similar groundwater high in northern Warren County has a similar pattern. North of it, groundwater moves to the southeast to the Missouri River in St. Charles County while south of it, water moves to the southwest.

PENNSYLVANIAN AQUIFER

The Pennsylvanian strata in the Northeastern Missouri groundwater province are generally of low permeability and are not considered to be an important water-supply source. Thus, no groundwater storage estimates were made for these materials. The Pennsylvanian is absent throughout much of the eastern part of the province. In the southern part of the province, the Pennsylvanian is from zero to about 100 ft thick, and is not considered a significant aquifer. Its thickness increases to the north and northwest where it can be as much as 300 ft thick. Yields of wells penetrating the Pennsylvanian are generally very low, ranging from nearly zero to perhaps as much as 10 gpm, but averaging less than 3 gpm. Like in northwestern Missouri, the quality of water from the Pennsylvanian is, at best, marginal. It generally contains excessive sulfate, iron and total dissolved solids.

There are opportunities for bedrock supplies from the Moberly Sandstone in central Randolph County and the adjacent part of western Monroe County. This channel sandstone underlies an area of about 87 mi^2. It is locally as much as 150 ft thick, and potentially can yield as much as 50 gpm (Gann and others, 1971). However, the average yield of wells penetrating the Moberly Sandstone is generally less than 15 gpm. Assuming an average saturated thickness of 50 ft, and a specific yield of 0.01, the Moberly Sandstone is estimated to contain about 9.1 billion gallons, or about 28,000 acre-ft water. Since yields and water quality are typically poor in other Pennsylvanian bedrock units in the province, no groundwater storage estimates were made for them.

GLACIAL DRIFT AQUIFER

In much of northeastern Missouri north of the freshwater-salinewater transition zone, the glacial drift is the only aquifer that is available. This is particularly true west of the area where Mississippian strata subcrop directly beneath the glacial drift. The glacial drift in the northeast Missouri locally contains fairly thick sequences of medium- to coarse-grained sand and fine to medium gravel. However, these seemingly permeable deposits yield only small to moderate amounts of water to wells, and the recharge or recovery of water in the wells is slow. This may indicate that the permeable sand and gravel bodies are hydrologically isolated, and are surrounded by low-permeability silt and clay in the drift. Available information indicates that the hydrologic characteristics of the drift in this province are much different from those of the glacial deposits in northwestern Missouri.

Relatively large-diameter dug or augered wells are generally used in this area because of the low permeability of the glacial drift. The wells allow a large volume of water to accumulate in them even through the yield of the aquifer may be only a gallon per minute or less. There are a few very local exceptions,

and these are quite probably the result of wells drilled into unmapped preglacial valley deposits.

The cities of Brasher in Adair County and Palmyra in Marion County are among the very few towns in northeast Missouri that have wells completed in glacial drift. Wells at Brasher are low-yield, and can produce about 35 gpm. Palmyra's wells are in a pre-glacial channel, and produce from coarse sand and gravel. The wells are about 100 ft deep, and can reportedly produce more than 600 gpm.

Groundwater movement in the glacial deposits is generally toward the local modern drainage. Water recharged to the drift in upland areas moves down-gradient towards nearby streams. The rate of groundwater movement is very low due to low-permeability drift. The best evidence for the low rate of groundwater movement through the glacial materials is the flow characteristics of area streams. Major rivers in northeast Missouri that drain several hundred square mile watersheds have very low dry-weather flows. Many of these streams even cease flowing during prolonged dry weather due to the low rate of groundwater inflow into the streams.

Groundwater storage estimates for the glacial drift aquifer in northeast Missouri are based on much less information than those made for northwest Missouri. All or parts of 10 counties, Adair, Clark, Knox, Lewis, Macon, Monroe, Randolph, Schuyler, Scotland and Shelby, contain glacial deposits that are greater than 100 ft thick. It is assumed that 10 percent of the vertical extent of glacial deposits thicker than 100 ft contains clean, water-saturated sand, and that the specific yield of the glacial drift is 0.05. Based on these assumptions, the glacial drift in northeast Missouri contains about 392 billion gallons, or about 1.2 million acre-ft.

Total dissolved solids in groundwater from glacial drift ranges from approximately 340 mg/L to almost 3,000 mg/L (Gann and others, 1971). In areas where the dissolved solids are higher, calcium sulfate seems to be the predominant water type. This may indicate leakage of water from the underlying bedrock formations. Sulfate ranges from about 15 mg/L to nearly 1,500 mg/L. Chloride in groundwater derived from glacial drift ranges from less than 10 mg/L to as much as 300 mg/L. In those instances where chloride is high, sodium is also high, indicating a bedrock source for at least part of the water. Water produced from glacial drift generally contains excessive manganese and iron. Manganese concentrations range from zero to more than 2.0 mg/L, with the average concentration being approximately 0.10 mg/L. Although a few samples contain no manganese, almost all water samples from glacial drift in this province have more than 1.0 mg/L of iron, and many have concentrations that range between 9.0 and 20 mg/L. Water with dissolved iron in concentrations above 0.3 mg/L and manganese above 0.05 mg/L will stain laundry, leave iron stains on plumbing fixtures, and generally have a metallic taste.

The water table in the glacial drift is generally very shallow, typically only a few feet below ground surface. Water levels in glacial drift wells fluctuate in response to precipitation. Unlike in the Ozarks where shallow bedrock wells typically show rapid, pronounced response to precipitation, glacial drift wells respond more slowly. Figure 66 is a groundwater-level hydrograph from a hand-dug glacial drift well in Schuyler County. This well is about 30 ft deep, and there are no other producing wells within one-half mile. Water-level rises in this well are due to recharge from local precipitation. Water-level declines are due to water draining from the aquifer into nearby surface drainages, and to a lesser extent transpiration. Despite its shallow depth, water-level changes in this well very slowly due to the low permeability of the glacial drift in this area. The lack of appreciable water-level change in 1988 and 1989 is due to low precipitation during those years. Precipitation measured at Kirksville, about 30 miles south of the observation well and the closest long-term National Weather Service observation station, was only about 15.91 inches in 1988 and 30.42

inches in 1989. Precipitation during 1990, 1991 and 1992 was more normal, ranging from 34.57 to about 44.4 inches. The very high water-levels observed in 1993 and 1995 were due to very wet conditions. For example, precipitation measured at Kirksville in 1993 exceeded 51 inches.

ALLUVIAL AQUIFERS

The most significant alluvial aquifers in the Northeastern Missouri groundwater province are, of course, the alluvial deposits of the Missouri and Mississippi rivers. Both of these aquifers have been discussed previously in this report, and will not be discussed further here. The alluvial deposits of the major Missouri and Mississippi river tributaries in the province are relatively untested. Some of the alluvial deposits of these smaller rivers may be capable of yielding 5 to 25 gpm for domestic supplies in upstream reaches where sufficient permeable sand and gravel are present. Where the deposits are thicker than 50 feet, the alluvial materials may yield as much as 100 gpm (Gann and others, 1971). The alluvium along the downstream reaches of the Fabius and Salt rivers probably has the best water possibilities of the northeastern Missouri rivers. However, drilling studies would be needed to substantiate this.

Sparse data are available concerning the quality of groundwater contained in alluvial valleys in the the Northeastern Missouri groundwater province. It is probably safe to assume that the alluvial waters of the Mississippi River tributary streams would be similar in chemical quality to that in the alluvium of the Mississippi River. Iron and manganese concentrations are probably above the recommended limits for most supplies, and would require some sort of iron removal treatment prior to use.

GROUNDWATER CONTAMINATION POTENTIAL

Groundwater contamination potential varies widely in this province because of the many different types of aquifers and the different geologic settings. Shallow Mississippian-age and older bedrock in the extreme eastern and southern parts of the province, where not

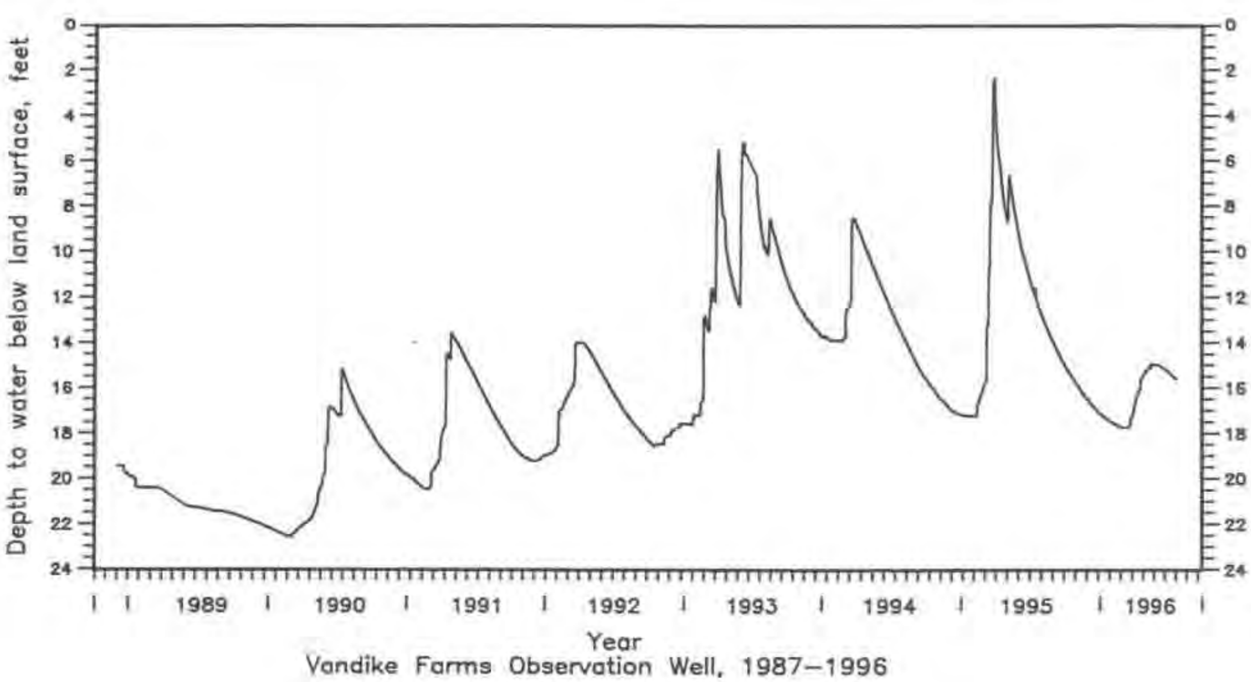


Figure 66. Groundwater-level hydrograph, Vandike Farms observation well, Schuyler County.

covered with low-permeability glacial drift, have much the same contamination potential as the same rock units in the Springfield and Salem plateaus. Where at least a few feet of glacial drift or Pennsylvanian-age bedrock overlies them, the potential for contamination due to surface activities is greatly diminished. Since most of the area south of the freshwater-salinewater transition zone is covered with Pennsylvanian strata, glacial drift, or both, bedrock aquifers here are not particularly prone to contamination.

Between Palmyra and St. Charles there are several areas where karst development occurs in Mississippian-age and older carbonate bedrock. Sinkholes, losing streams, caves and springs can be found in this area paralleling the Mississippi River, but the karst here is typically not nearly as well developed as it is in parts of the Salem and Springfield plateaus. Improper waste disposal in these small karst areas can adversely affect shallow groundwater quality, particularly at the numerous small springs draining the karst systems.

There is another, much more extensive karst area in the very southwest corner of this province in southwest Boone County. The Burlington-Keokuk Limestone here hosts numerous caves, the largest of which is the Devils Icebox south of Columbia. The Devils Icebox drains a very extensive sinkhole plain and losing streams that overlie or are adjacent to it. Improperly sited and poorly constructed private waste-disposal systems, barnyard runoff, and trash dumped in sinkholes caused pollution problems in this cave for many years, but more stringent zoning standards, coupled with education and development of central sewer systems, have greatly decreased the introduction of wastes into this karst system.

The glacial drift deposits in the Northeastern Missouri groundwater province are generally finer-grained and of lower permeability than those in the northwestern part of the state. Deeper horizons in the drift are not typically affected by surface activities, but shallow groundwater in the upper few feet of the drift is commonly affected by septic systems and agricultural activities. Bacterial quality and nitrate levels for all supplies derived from very shallow unconsolidated sediments may be suspect. Since they contain no casing, per se, hand-dug wells in glacial drift and alluvium are especially prone to contamination. Augered wells, since they contain some type of casing, can be sealed, but their shallow depths more easily allow the introduction of surface water and shallow vadose water that may contain bacteria. While persons using private groundwater supplies in all of Missouri's groundwater provinces should test their water on a regular basis, it is most important to do so in northern Missouri. Northern Missouri, especially northeast Missouri, has historically had the greatest incidence of serious health problems resulting from poor-quality private water supplies, typically due to bacteria or high nitrate concentrations in shallow glacial drift wells. Contamination of water, resulting from a combination of poor waste disposal and fertilizing practices and poor well construction, is still a major concern in areas where shallow hand-dug and augered wells are still widely used by rural residents.

WEST-CENTRAL MISSOURI GROUNDWATER PROVINCE

INTRODUCTION

The West-Central Missouri groundwater province is bounded on the south and east by the Springfield Plateau groundwater province, by the Missouri River to the north, and the Kansas-Missouri boundary line to the west. It includes all or parts of 12 counties including Jackson, Cass, Bates, Vernon, Barton, St. Clair, Henry, Johnson, Lafayette, Pettis, Saline and Cooper, and encompasses an area of about 5,080 mi^2. Most of this area is within the Osage Plains physiographic region. The eastern and southern margins of the province coincide with the freshwater-salinewater transition zone. Thus, the deeper aquifer zones of the Springfield Plateau, Ozark, and St. Francois aquifers throughout the West-Central Missouri groundwater province contain water that is too highly mineralized for most uses. With perhaps the exception of the igneous rock area of the St. Francois Mountains, the Osage Plains of west-central Missouri probably have the least potable groundwater resources in the state. This has prompted the widespread development of rural water districts to serve much of the western part of this area. Most of the public water supplies in the Osage Plains depend on surface water for their raw water supply source.

GEOLOGY

Pennsylvanian-age formations form the bedrock surface throughout much of this province. The only exception to this is in southern and eastern parts of Saline County, and extreme northwestern Cooper County, where Mississippian-age bedrock is the shallowest consolidated rock (figure 67). The older Mississippian, Ordovician and Cambrian formations that crop out in the Ozark plateau are also present in the subsurface in west-central Missouri. However, since these older formations contain highly mineralized water in this province and are not usable aquifers, they will not be discussed further. Thin deposits of glacial drift overlie the bedrock formations in a narrow band just south of the Missouri River in Jackson, Lafayette, Saline, and Cooper counties. Table17 is a stratigraphic section showing formations which underlie this province.

Mississippian-age rocks which directly underlie Quaternary sediments in Saline and Cooper counties are Osagean Series, and the shallowest bedrock unit is the Burlington-Keokuk limestone. The Burlington-Keokuk, as in the Springfield Plateau groundwater province, is a coarsely-crystalline limestone, with scattered layers of chert nodules.

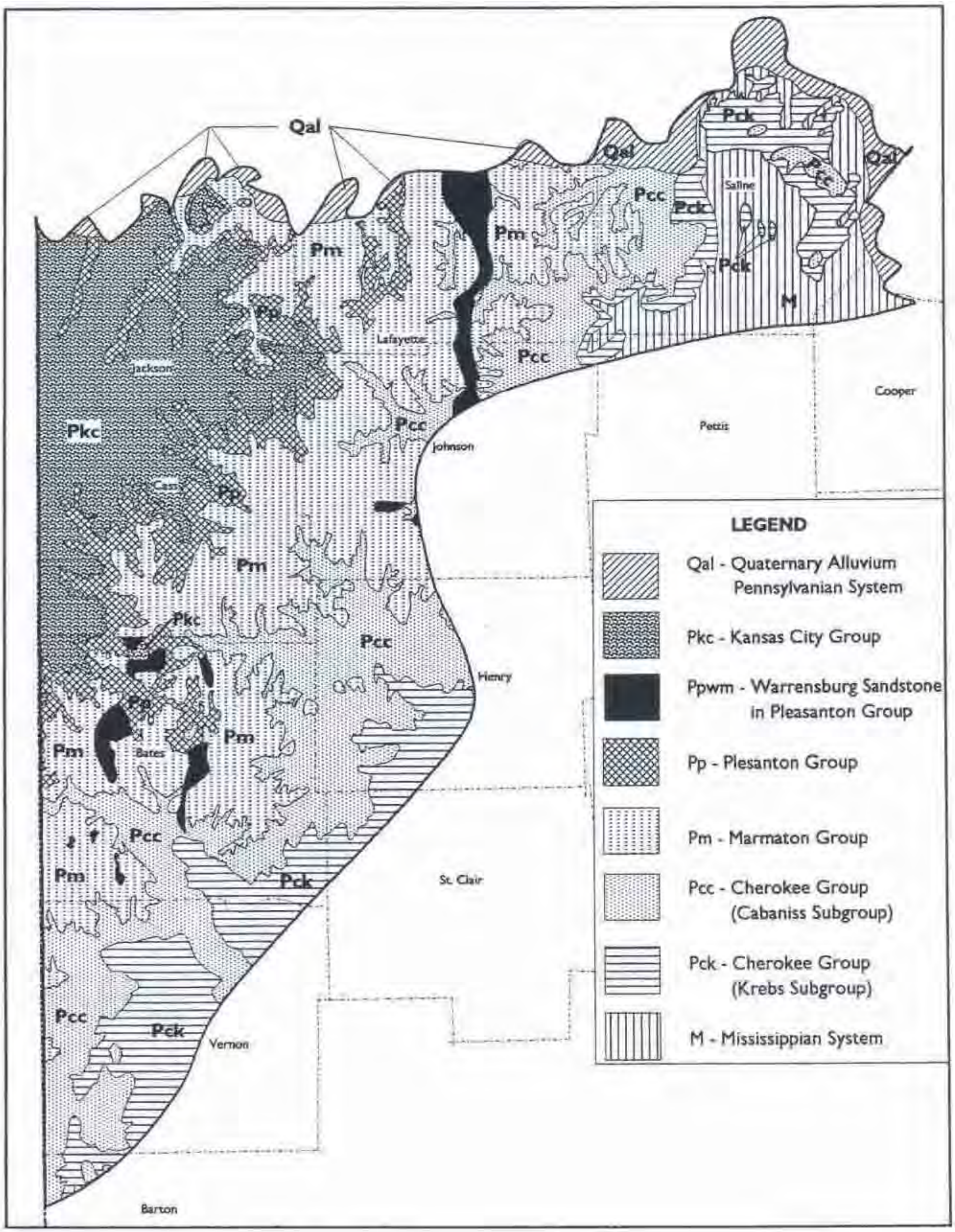


Figure 67. Generalized geologic map of the West-Central Missouri groundwater province. Geology from the *Geologic Map of Missouri* (DGLS, 1979).

System	Series	Group or Formation	Lithology	Hydrology
Quaternary	Pleistocene and Recent	Undifferentiated glacial drift and alluvium	Clay, silt, sand and gravel, in northern part of province, just south of the Missouri River is glacially derived. Some loess near the river valley.	Missouri River alluvium yields >1,000 gpm. Drift and alluvium-filled preglacial channels may yield 50 to more than 500 gpm. Elsewhere, drift may yield 0-5 gpm.
Pennsylvanian	Missourian	Kansas City	Massive limestone formations with intervening shale formations. Some of the shale intervals have included sandstone beds. In the lower part of the group these are thin black, fissil shale members.	Small amounts of water (1-3 gpm) available from limestones and black shales near the outcrop line. Where more deeply buried, water is highly mineralized.
		Pleasanton Group	Thick clastic shale with a basal siltstone or very fine-grained sandstone. Locally, there are two other thick channel sandstones in the upper half of the group.	Not considered to be water bearing. Locally, may yield very small amounts of water from sandstone beds. Water may be poor in quality.
	Desmoinesian	Marmaton Group	Fewer sandstone bodies than preceeding group, with more thin limestones and thick shale sequences.	
		Cherokee Group and Krebs Subgroup	Thin sandstones and siltstones with intervening shales. The shales locally have coal seams. Thin limestone beds occur at widely scattered intervals.	May yield small amounts of water from sandstones, (3-20 gpm). Water may be poor in quality
Mississippian	Osagean	Burlington Limestone	Medium- to coarse-crystalline, medium- to thick-bedded limestone.	Yields very small amounts of water to wells locally. May contain highly-mineralized water.

Table 17. Stratigraphic section of the West-Central Missouri groundwater province.

Because of the cyclic nature of the Pennsylvanian deposits, which overlie the Mississippian strata, there are repetitive occurrences of lithologic types. The sheer number of individual thin formations in the Pennsylvanian necessitate that it be discussed by groups rather than by individual formations.

The Cherokee Group in this province is composed of thin sandstone and siltstones, with intervening shale bodies. The shales locally contain thin coal seams. Thin marine limestone beds are present throughout the section at scattered intervals. The most persistent lithologies of the Cherokee are the thick shale and the sandstone sequences.

Overlying the Cherokee Group in this province is the Marmaton Group. The Marmaton differs from the underlying Cherokee by having fewer sandstone bodies within the formations, and more thin limestone formations with intervening thick shale sequences. The most persistent lithologies of the Marmaton are the thick shales with thin limestone beds.

Overlying the Marmaton Group, is the Pleasanton Group. The base of the Pleasanton marks a break in the depositional sequence during Pennsylvanian time, forming a regional disconformity (Howe, 1961). The Pleasanton lithology in the West-Central groundwater province is predominantly a thick sequence of shale with a basal siltstone or very fine-grained sandstone. Two other thick sandstone bodies are present locally in the upper half of the group. These sandstones combined are called the Warrensburg Sandstone, and are channel sandstones that are very similar to the Moberly Sandstone described previously in the Northeastern Missouri groundwater province.

Overlying the Pleasanton Group is the Kansas City Group. The Kansas City Group is typified by massive limestones with intervening shale formations. Topographically, it forms an escarpment at its outcrop, and is in stark contrast to the underlying thick shale sequences of the Cherokee, Marmaton and Pleasanton groups. Thin, fissile, black shales are present in some of the limestone formations in the lower part of the Kansas City Group. Locally, a few of the shale units have beds of fine-grained sandstone. The most persistent lithology apparent in the Kansas City Group is limestone.

The southern extent of Pleistocene glaciation, shown previously in the report in figure 58, roughly parallels the Missouri River, and passes through the northern tier of counties in this province. Quaternary-age clastic sediments consisting of clay, silt, sand and gravel are present as far south as southern Saline and central Cooper counties. These sediments are relatively thin over much of the area. This is likely because near the southern extent of the glaciers advance, the thickness of the ice was probably less than to the north, and the amount of debris transported was also proportionally less. There is a buried alluvial valley in Saline County that trends northwest-southeast across the county. It is either a preglacial channel, or a product of ice-damming of the Missouri River during glaciation. Wells drilled into this buried valley show thicknesses of glacial drift of 50 to 125 ft.

HYDROGEOLOGY

The groundwater resources of this province are meager. Table 17 shows the groundwater characteristics of the various rock groups. Pennsylvanian-age bedrock units are locally capable of yielding modest quantities of marginal quality groundwater. The greatest groundwater potential is alluvial and drift-filled preglacial valley deposits along the northern edge of the province.

Pennsylvanian Bedrock Aquifer

Small quantities of groundwater, generally one to three gallons per minute, are available to wells drilled into sandstone units in the Cherokee Group, particularly near the crop line of the group, in Saline, Lafayette, Johnson, Henry, Bates and Vernon counties. Wells drilled to depths no greater than 200 ft can usually obtain small quantities of marginal

quality water in these areas. Further to the west, away from the outcrop line of the group, the units are more deeply buried, and water quality is poorer. This is due to the extremely low vertical and horizontal permeabilities of the units, and the low groundwater gradients within the formations. With low vertical permeabilities, recharge potential is also quite low. Permeabilities in the Marmaton Group are even lower than those in the underlying Cherokee Group. Very few wells drilled into this sequence of rocks yield adequate amounts of potable water to sustain even the most modest domestic needs. For this reason, many farm families in areas underlain by the Marmaton Group must use cisterns or some sort of surface water source for their water supply. What domestic wells are able to obtain water from the Marmaton Group, do so from the scattered sandstone bodies.

The Pleasanton Group exhibits even lower permeabilities and potential for groundwater supply than the underlying Marmaton Group. What small amounts of water that can be locally recovered are from the sandstone found at the base of the group, and from the north-south trending, sandstone-filled channel, which trends from northern Henry County to the Missouri River in Lafayette County, passing through Warrensburg. This, the Warrensburg Sandstone, underlies an area of about 106 mi^2. About 56 mi^2 of the area that it underlies is within the West-Central Missouri groundwater province, the remaining 50 mi^2 is south and east of the freshwater-salinewater transition zone in the Springfield Plateau groundwater province. In northern Johnson and Lafayette counties, well logs show the Warrensburg to be from about 100 ft to a maximum of 150 ft thick. Yields of 10 to 15 gpm are locally possible from the two sandstones comprising this unit; occasionally yields of as high as 25 to 30 gpm are reported. Yields of wells penetrating the lower sandstone usually range between one to three gallons per minute. Assuming a saturated thickness of 100 ft and a specific yield of 0.05, the Warrensburg Sandstone contains about 58.4 billion gallons of recoverable water, or about 179,000 acre-ft.

The Kansas City Group has slightly better potential than the Pleasanton and Marmaton groups for yielding water to wells. The thicker limestone units may yield water from bedding planes and fractured intervals, and the black, fissile shales found in the lower part of the Group have fair horizontal permeabilities. Wells drilled near the outcrop line of the group, where the units are not deeply buried, are able to obtain three to five gpm from the limestones and black shales. As in the area underlain by Cherokee Group sandstones, wells drilled deeper than approximately 200 feet usually encounter mineralized water.

A somewhat unusual well recently drilled in Jackson County shows that under certain circumstances the Kansas City Group can yield relatively large quantities of water. This well, or more accurately a slightly inclined bore hole, was constructed to house a fiber optics cable. The 8-inch diameter hole was drilled through a ridge top overlooking the Missouri River just downstream of where the Kansas River enters the Missouri River. The southern end of the borehole is some 75 ft higher than the northern end, which exited the hillside near the edge of the Missouri River alluvium. Most of the hole is in limestone, probably the Winterset Member of the Dennis Formation or the uppermost Bethany Falls Member of the Swope Formation. Upon exiting the ground, water began discharging from the hole at an estimated rate of 300 gpm, and the flow rate did not appreciably decline for a three-month period. Specialized grouting techniques had to be employed to seal the casing in the drillhole. The quality of the water discharging from the hole strongly indicated it was from the Pennsylvanian strata. Chloride and sulfate contents were about 350 and 450 mg/L, respectively, and total dissolved solids was about 1,500 mg/L. The calcium-magnesium ratio indicated that the water had been in contact with limestone. Apparently, the slightly inclined drillhole intersected bedding plane and

joint openings that were sufficiently interconnected to allow a large quantity of water to drain from this normally low-yield unit (Dave Taylor, 1997; personal communication).

Direction of groundwater movement in the shallow Pennsylvanian bedrock is topographically controlled. Potentiometric surface gradients are very low in the deeper Pennsylvanian strata. Direction of movement in the more deeply buried rocks is toward the north.

Groundwater quality in this province, even from shallow wells, is at best marginal. Total dissolved solids content of water from relatively shallow wells producing from Pennsylvanian strata range between 450 mg/L and 1,500 mg/L, with the average being approximately 750 mg/L. The constituents that typically cause the elevated concentrations are sodium and chloride. Chloride concentrations are frequently in excess of 250 mg/L. The reasons for higher mineral concentrations are low recharge rates for water entering the system, low vertical and horizontal permeabilities, which cause poor groundwater circulation, and long-term residence of groundwater in the system. The dissolved solids concentration of water generally increases as the length of time it is in contact with the earth materials increases.

It is difficult to estimate the volume of potable groundwater in the Pennsylvanian aquifer in this area. For calculation purposes, it is assumed that there is 50 ft of saturated material containing marginally usable groundwater, and that the specific yield is 0.01. Based on this, the Pennsylvanian aquifer in west-central Missouri, which covers an area of about 4,500 mi^2 is estimated to contain about 454 billion gallons, or about 1.4 million acre-ft.

Alluvial and Glacial Drift Aquifers

The most significant alluvial aquifer in this area is the Missouri River alluvium, which was discussed in detail earlier in the report. There are two other unconsolidated alluvial or glacial drift aquifers that have the capability of supplying relatively large quantities of good quality water. The first is a 16-mile-long, 1- to 2-mile wide alluvium-filled channel that begins at the southern edge of the Missouri River floodplain in central Jackson County, extends to the southeast to Lake City, then trends to the northeast and intersects again with the Missouri River alluvium in northeastern Jackson County (figure 68). This channel likely formed as the result of ice damming of the ancestral Missouri River during the Ice Age, forcing the river to the south where it eroded a new bedrock channel. The new channel included part of the lowermost Little Blue River channel, which at that time flowed to the east-northeast. Later, after the ice sheets had retreated, the river resumed its former coarse and abandoned the alluvium-filled bedrock channel. Today, the Little Blue River follows this valley from Lake City, northwest, to the Missouri River, and Fire Prairie Creek follows it from Lake City to the northeast and east through Buckner to where it reconnects with the Missouri River valley.

Much of the knowledge concerning this buried channel comes from studies performed in the early 1940s when the Lake City Ordnance Plant (Remington Arms Co.) was built in the valley overlying the buried channel. Several water supply wells were constructed in the buried channel. Most encountered 80 to 90 ft of alluvial materials, the lower part of which was coarse sand and gravel. Water levels were initially about 15 to 20 ft below land surface, and yields of wells constructed in the channel were generally 300 to 400 gpm (Anderson and Greene, 1948). Pumping tests showed that specific capacities were relatively high, ranging from 50 to about 200 gpm/ft of drawdown. The more favorable parts of the aquifer have transmissivities of from about 12,000 gpd/ft to 16,000 gpd/ft (1,604 to 2139 ft^2/day). The alluvium in other parts of the buried channel may have significantly lower transmissivities. Groundwater storage estimates assume an average buried valley width of 1 mi, a length of 15 mi, a saturated

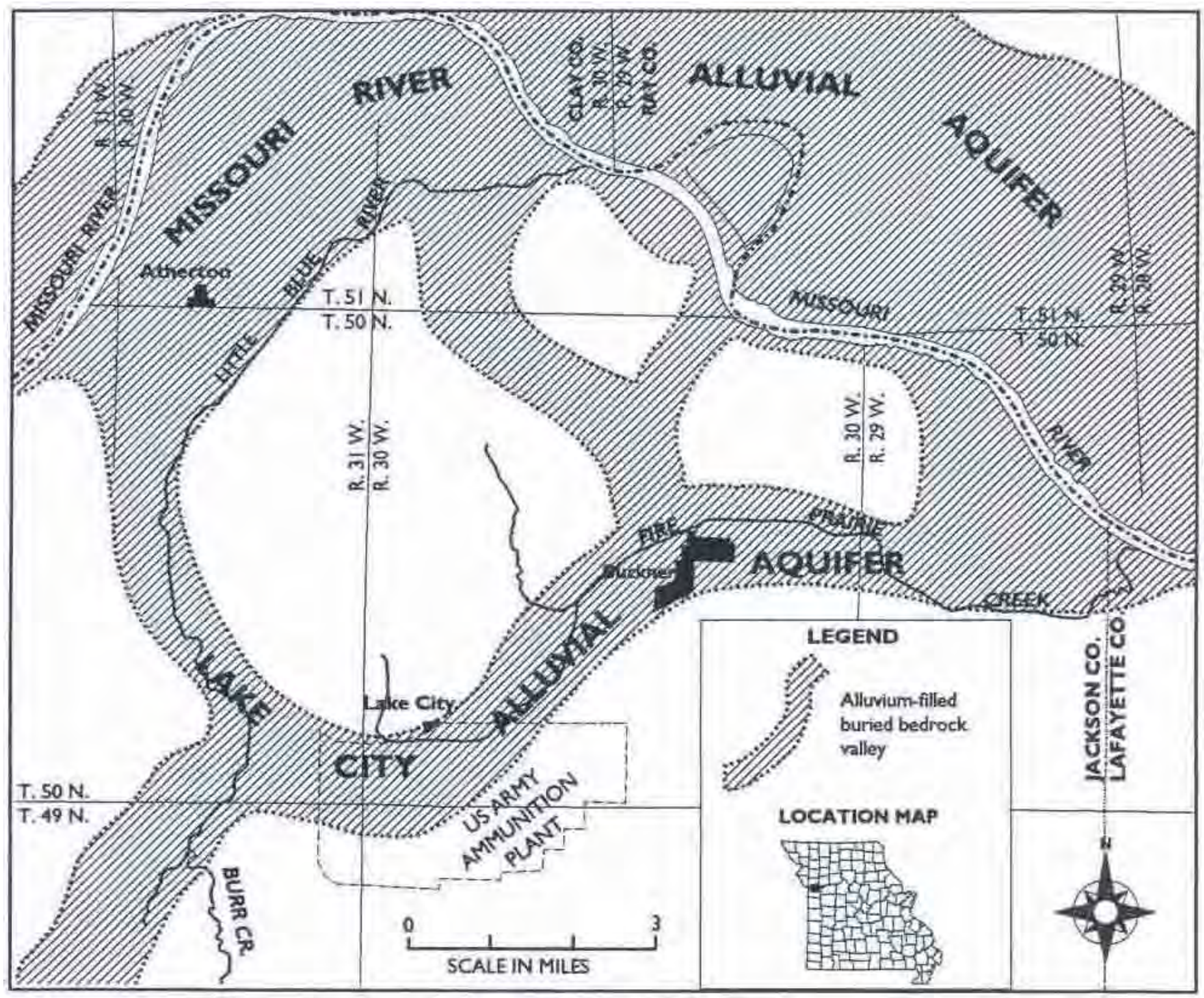


Figure 68. Lake City alluvial aquifer, Jackson County (buried valley locations from Anderson and Greene, 1948).

thickness of 60 ft, and a specific yield of 0.15. Based on this, the buried valley contains an estimated 28.2 billion gallons, or about 86,400 acre-ft of water. Part of the aquifer underlying the ordnance plant has been badly contaminated with organic chemicals due to improper waste disposal at the facility. Remedial investigations and aquifer clean-up projects are planned or underway.

The second clastic-filled channel trends to the southeast through Saline and the northwestern tip of Cooper counties. It, too, connects at both ends with the Missouri River alluvium. The western end of the channel begins at about Malta Bend, passes just north of Marshall and through Nelson where it crosses into Cooper County, and then trends nearly due east to where it intersects with the Missouri River valley. This channel likely developed during the Pleistocene due to glacial ice damming the Missouri River in the Big Bend area of the river somewhere near Glasgow. The damming of the river forced water to seek a new course to the south, and resulted in a bedrock channel that was later filled with sediments. It also caused glacial ponding, and associated sediment deposition at the upper end of the new channel.

Miller (1971) divides these glacial-fluvial deposits into three units (figure 69). The first, which is a large area of thick glacial drift west of Marshall and south of Grand Pass in northwest Saline and northeast Lafayette counties, has a moderate groundwater potential. In Saline County, this deposit underlies about 77 mi^2, and in Lafayette about 40 mi^2. The glacial drift ranges from locally absent to about 100 ft thick, is moderately fine-grained, and can yield 5 to 10 gpm.

Coarse sands and gravels up to about 150 ft thick accumulated beneath a high terrace known as Teteseau Flats. This deposit has been attributed to glacial ponding of the Missouri River (Bretz, 1965). The highest well yields are associated with the coarser part of this deposit, which covers an area of about 28 mi^2. The city of Marshall has 10 wells producing from it that can each supply about 1,000 gpm. Southeast of Teteseau Flats, the current surface channel, Salt Fork, roughly coincides with the buried channel. However, the channel narrows to less than 2 miles wide. In Saline County, the narrow part of the channel underlies an area of about 36 mi^2, and in adjacent Cooper County it underlies about 9 mi^2. Although the unconsolidated materials are as much as 100 ft thick, they yield more modest quantities of water than those underlying Teteseau Flats. In some places, properly located and constructed wells can yield, perhaps, 100 gpm, but numerous test wells and production wells drilled about a mile north of Marshall for a state school found yields to average closer to 50 gpm. Despite relatively thick, clean sand deposits in this channel, numerous well logs indicate that in many places it yields little or no water.

The total volume of groundwater contained in the glacial materials in Lafayette, Saline and Cooper counties is estimated to be about 214.5 billion gallons, or about 658,000 acre-ft. Of this, about 33.4 billion gallons or 102,400 acre-ft are in Layfayette County, and about 10.5 billion gallons or 32,340 acre-ft are in Cooper County. The remaining 170.6 billion gallons or 523,160 acre-ft are in Saline County.

The quality of water from these glacial and alluvial deposits is generally good. Total dissolved solids, chloride, and sulfate are generally within recommended drinking water parameters, but iron and manganese may be elevated. In some areas, highly-mineralized water ascending from deeper bedrock aquifers affects water quality in the lower parts of the glacial and alluvial aquifer.

GROUNDWATER CONTAMINATION POTENTIAL

The potential for groundwater contamination is low to moderate in the West-Central Missouri groundwater province. It is much lower than in any of the other provinces discussed in this report, due to low

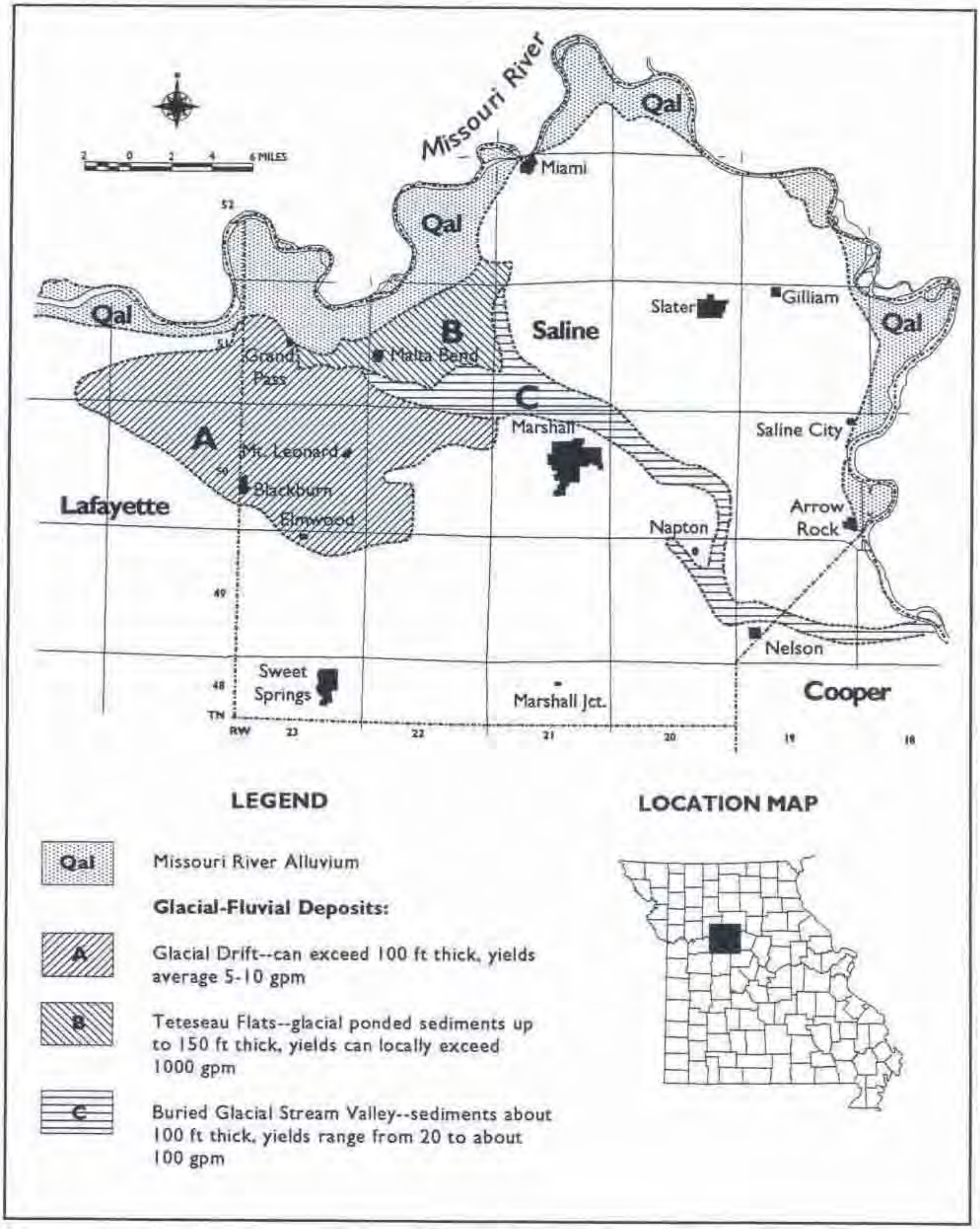


Figure 69. Preglacial valley and the Teteseau Flats area, Saline, Lafayette and Cooper counties (modified from Miller, 1971).

permeabilities of the underlying bedrock. Recharge is very limited, and circulation is very slow. Surface water is much more susceptible to contamination than the groundwater system.

Depending on the thickness and permeability of shallow alluvial materials, the alluvial and glacial drift aquifers in the northern part of the province are more likely prone to contamination than the bedrock aquifers. Widespread groundwater contamination has occurred at the Lake City Ordnance Plant due, at least in part, to leakage from waste-disposal lagoons into the buried channel.

THE UTILIZATION OF GROUNDWATER FOR WATER SUPPLY IN MISSOURI

INTRODUCTION

The use of groundwater for water supply in Missouri is as much about drilling technology as it is about resource availability. Prior to the development and availability of drilling machines, groundwater use in the Ozarks mostly centered around springs. An afternoon's drive through the rural Ozarks will attest to this; many older homes and farmsteads were built near springs that not only supplied household and farm water needs, but also were used for cooling milk and other perishables. Larger springs often became the focal points for small communities, providing power to grist mills, saw mills, and other water-driven industries as well as water for the residents and their livestock. Towns large and small took advantage of springs; a few still do. Springfield's first public water supply was Fulbright Spring at the north edge of the city. Deep wells, surface-water reservoirs, and stream intakes were added as the city grew, but even today the spring still remains a very important source of raw water. Between 1971 and 1993, about 50 percent of the 110 billion gallons of water treated and distributed through the Fulbright Water Treatment Plant was supplied by Fulbright Spring. At the other end of the population scale, the village of Mill Spring in Wayne County, which has a population of about 252, until recently used a spring in town for public water supply. Most towns have found that the overall quality of untreated water from springs is generally much better than that of streams.

WATER WELL DRILLING IN MISSOURI

Before the turn of the century, the relatively few water wells in Missouri that were present were generally dug by hand, some to depths of more than 50 ft. It was not until after about 1900 that drilling machines were available for constructing large capacity wells for towns and cities, and many more years after that before even the most affluent private citizens could afford to have a well drilled. Prior to about 1930, groundwater was much more widely used in northern Missouri than in the Ozarks. It proved far easier to dig wells in the relatively soft glacial drift deposits in the northern half of the state where the water table was only a few feet below land surface, than in the residuum and bedrock of the Ozarks, where the water table was typically much deeper. Hand-digging a northern Missouri well had another advantage; if a usable quantity of groundwater was not encountered at a reasonable depth, the hole could still be used as a cistern for storing runoff water collected from roof-tops.

The first well drilled in the United States was not in search for water, but for a more valuable commodity...oil. The historic Drake oil well, drilled in 1859 near Titusville, Pennsylvania, reached a depth of 65 feet, and is credited for starting the American petroleum industry (Gatlin, 1960). The technology used to drill the Drake well, however, did not originate in the United States, but rather in China where the same drilling principals, although more crudely applied, had been used

for centuries to drill salt brine wells, some more than 3,000 ft deep (Driscoll, 1987). Water well drilling technology has to a great extent mimicked oil well drilling technology. Many of the techniques and much of the equipment developed for oil exploration and exploitation have been modified for use in the water well industry. However, both cable tool and rotary drilling equipment were first used for obtaining water, and later used in search of oil.

There are few industries other than the well drilling industry that rely so heavily on human ingenuity for success. The phrase "necessity is the mother of invention" could have easily been coined to describe water well drillers. Although the drilling rig does most of the physical work, the skill and experience of the driller is a key factor in the successful completion of a well. Essentially all of the drilling and construction of a well is carried out below ground where it cannot be directly observed. This normally presents few problems. But when difficulties arise, the experience of the driller is called upon to remedy the problem, whether it be fishing lost or broken equipment from the bottom of the drillhole, or salvaging a drillhole that encountered deeply-weathered or highly-fractured rock.

Throughout the years there have been many different types of drilling equipment used in Missouri. Some types of drilling rigs can be used for constructing all types of wells while others are very specialized and will only work when drilling through certain materials. The earliest drilled water wells in Missouri were constructed using a *cable tool drilling rig* (figure 70). The cable tool drill, also called a *churn drill* or *percussion drill*, uses a heavy, hardened steel bit attached to the end of a cable to drill the hole. The bit is repeatedly raised and allowed to fall about 20 to 40 times per minute. The impact of the drill on the bottom of the hole pulverizes the rock. Until groundwater is encountered, water is poured into the well to mix with the ground-up rock and other earth materials, called cuttings, to form a slurry. Additional drill cable is spooled out as the hole is deepened. After every five feet of drilling, the cable and bit are pulled from the hole so that the cuttings can be removed from the well. A bailer, consisting of a long hollow tube with a dart valve at the bottom, is lowered to the bottom of the drillhole to remove the cuttings. The bailer is lowered using the sand line, which is a small diameter utility cable that is secondary to the heavier drilling cable. The dart valve is at the bottom of the bailer, and opens when the bailer strikes the bottom of the hole, allowing the cuttings to fill the bailer. When the bailer is lifted, the valve closes and the cuttings are transported to the surface.

Cable tool drilling rigs were the mainstay of the water well drilling industry for many years. Even today, numerous cable tool rigs are still used in Missouri, although faster rotary drilling rigs are used to drill the vast majority of the water wells. In fact, the older churn drills actually have a few advantages over their faster, newer counterparts. Cable tool rigs, because they are lighter, simpler, and less complicated, cost much less to purchase, and have much lower operating costs. A relatively small gasoline engine can power a cable tool rig where larger air rotary rigs require one or more large diesel engines. Since they can normally be mounted on relatively small truck frames, cable tool rigs can be more easily maneuvered into confined spaces. A major disadvantage of the cable tool rig is the drilling rate. A modern air-rotary drill can complete a well several hundred feet deep in a days time where as a cable tool rig may take a week or more to drill to the same depth. Despite this, in areas where there is deep weathering, large bedrock openings, and problems with the loss of drilling fluids, cable tool rigs are still preferred by many drillers.

The *rotary drilling rig* (figure 71) was introduced into the oil industry about 1901 when a rotary drilling rig was used to drill the discovery well at the Spindletop oil field near Beaumont, Texas. The rig, however, was brought from South Dakota where it had been used for drilling water wells in relatively soft sediments. The first rotary drilling bits were called fish-tail bits or drag-type bits. These

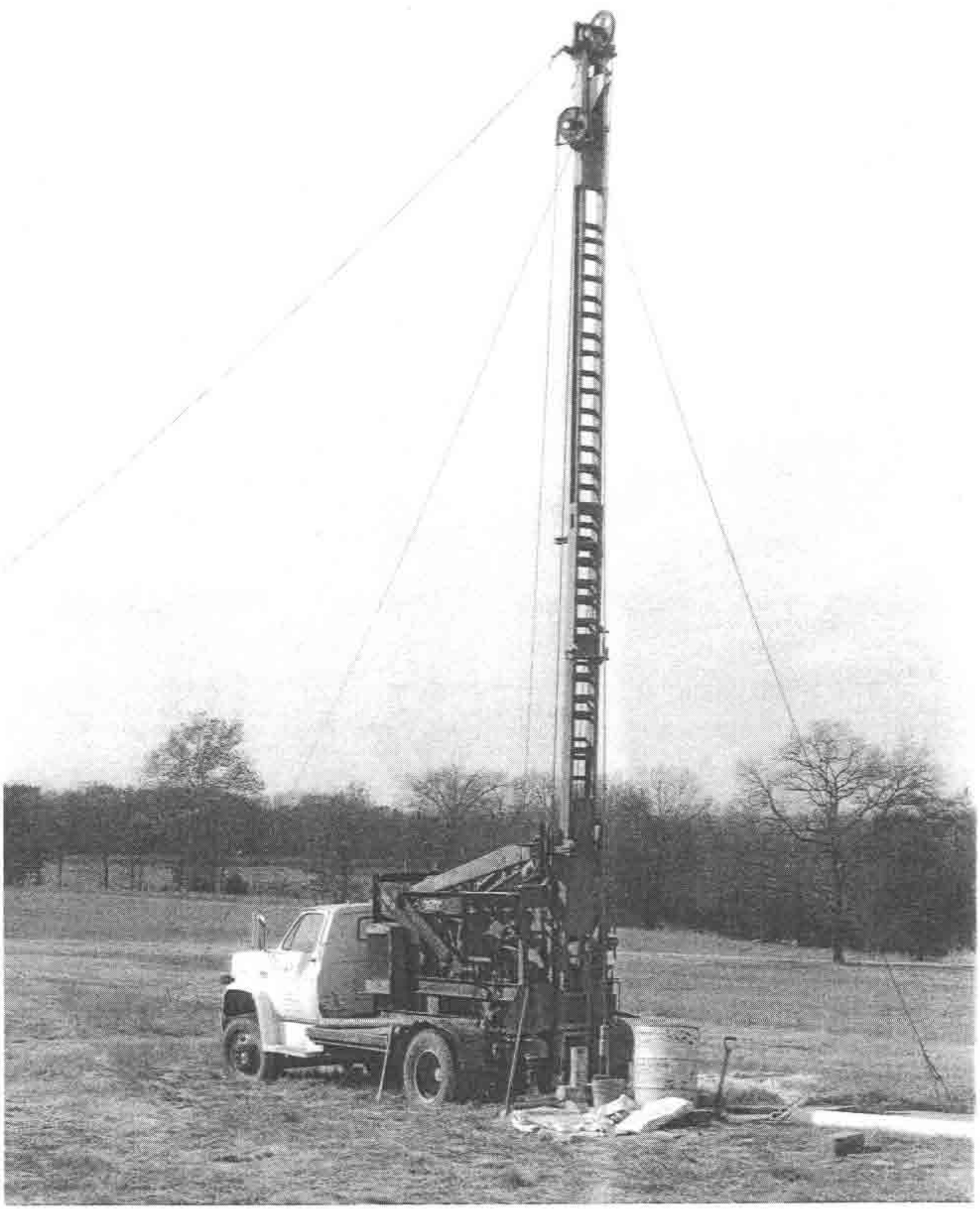


Figure 70. Cable tool drilling rig. Photo by Jim Vandike.

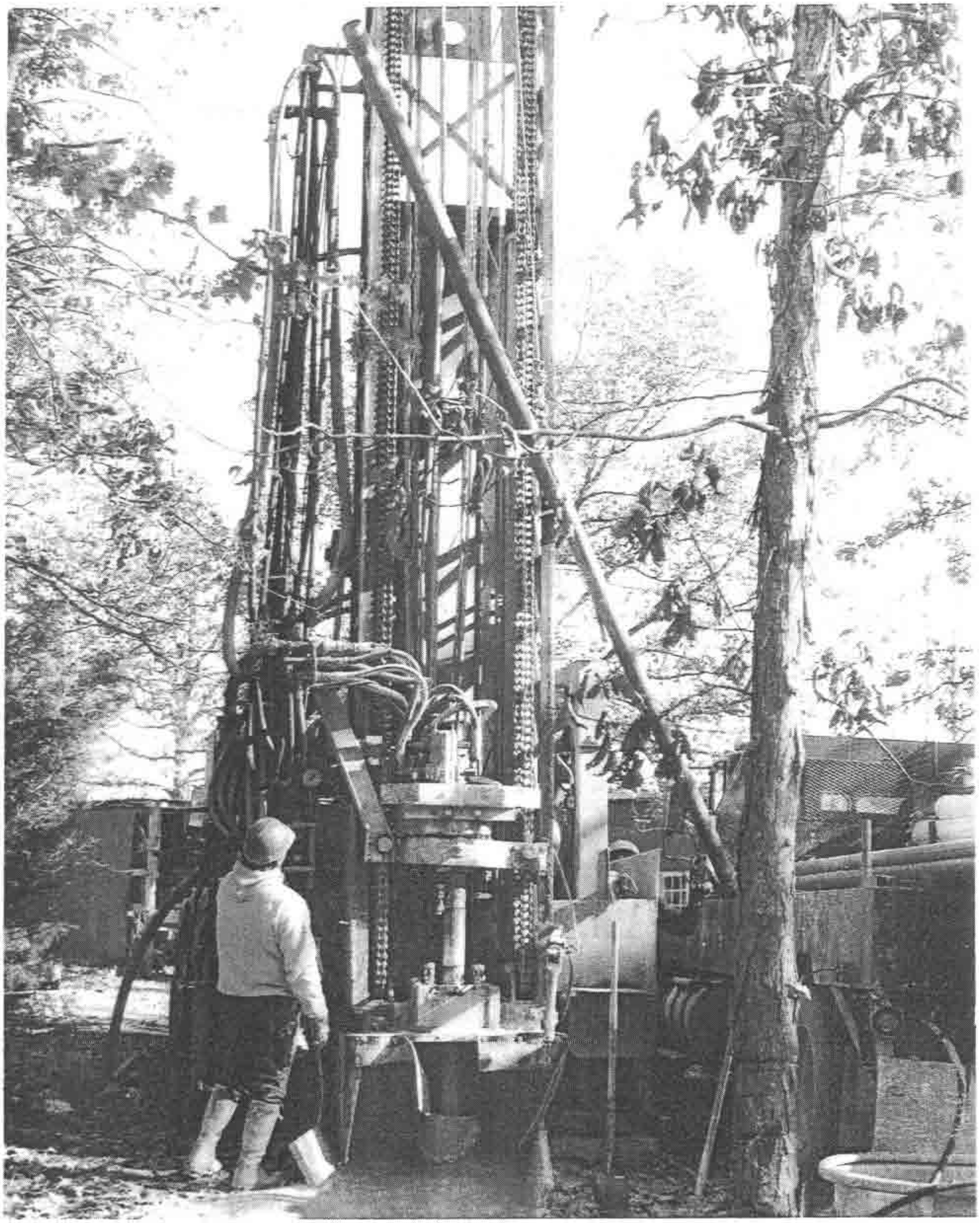


Figure 71. Rotary drilling rig. Photo by Jim Vandike.

were made of hardened steel, and could only be used for drilling in unconsolidated sediments or very soft rock such as shales. Roller or cone-type bits were later developed to allow drilling through harder rock units. Some of these use hardened-steel teeth, while others are equipped with tungsten carbide buttons. Within a few years after its introduction, rotary drilling began replacing the cable tool drill. Today, more than 90 percent of oil, gas, mineral test and water wells are drilled using rotary drilling equipment (Campbell and Lehr, 1973).

The rotary drilling method uses a bit placed at the end of a drill string consisting of hollow drill pipe and collars. The drill string is rotated from above and downward pressure applied. More drill pipe is added as the hole deepens. The drill pipe can be rotated one of two ways. The first rotary rigs used a stationary rotary table at the bottom of the drill rig to turn the drill pipe. The rotary table turns a square or fluted pipe called a kelly that is attached to the top end of the drill string. The kelly slides downward through the opening in the rotary table as the hole deepens. Cables and pulleys are used to raise the drill pipe. This method is still widely used in the oil industry or where very deep holes are drilled.

Most of the rotary water well drilling rigs in Missouri use a top-head drive. Here, the drill pipe is attached to a hydraulic motor that can move up and down the derrick. The hydraulic motor rotates the drill pipe, and the top-head is moved up and down using large hydraulic cylinders on the sides of the derrick. These can raise the heavy drill string, and also be used to transfer the weight of the drill rig to the drill string.

The cuttings are removed from the hole using one of several methods. The first rotary drilling rigs used water or other drilling fluid to clean the cuttings from the hole. The drilling fluid was pumped down the inside of the drill pipe. It exited through openings in the bit, and in the process cooled and lubricated the bit as well as removed the cuttings and broken rock. The drilling fluid moves up the hole to the surface where it is diverted into a series of mud pits where the cuttings settle out. After the cuttings settle out, the drilling fluid is reused. In some instances, water is used as the drilling fluid. However, in the early days of rotary drilling it was found that other substances such as bentonite, barite, and other dense solids could be mixed with the water to improve removal of the cuttings, control loss of fluids into permeable formations, and stabilize the sides of the drillhole in formations prone to collapse.

Another rotary technique often used where wells are drilled into soft, unconsolidated sediments that are prone to collapsing into the drillhole is called *reverse circulation rotary drilling*. With this technique, drilling fluid, consisting mostly of water, is pumped down the borehole on the outside of the drill pipe, and is drawn back to the surface through the inside of the drill pipe. This technique is used predominately where very large diameter holes are being drilled in loose materials such as unconsolidated sands, or where the drillhole will not stay open using conventional rotary techniques. For example, wells in the Wilcox and McNairy aquifers in the Southeastern Lowlands are commonly drilled using the reverse rotary method. The velocity of the fluid filling the drillhole is low enough to preclude excessive erosion of the soft sediments. The drillhole must be kept full of fluid at all times, even when drilling ceases. Otherwise, the hole can collapse because of the loss of hydrostatic pressure on the walls of the bore hole.

Today, the most widely used rotary drilling technique in Missouri is *air rotary drilling*. With air rotary, large volumes of high-pressure air are forced down the drill stem to cool the bit and force the cuttings back to the surface. Normally, a small quantity of water and drilling additives are added to the air. The additives used are foams or soaps that help cool and lubricate the bit and aid in returning the cuttings to the surface. Probably the most significant development since the invention of the rotary drilling rig is the introduction of the pneumatic hammer bit. This type of bit operates much like a large diameter jack ham-

mer. It is powered by the high-pressure air that is forced down the drill pipe which causes the bit to rapidly strike the bottom of the drillhole while the drill stem is rotated. The use of a hammer bit increases the rate of drilling several fold over that of conventional roller-cone bits. Using a hammer bit, it is possible to drill several hundred feet per day through very hard rock.

Although rotary and cable tool drilling rigs can successfully be used to drill in most conditions, there are several other drilling machines that have been developed for drilling in special conditions. Several of these are used in Missouri. *Jet drilling* is used to construct relatively small diameter wells in unconsolidated sediments or very soft rock. With this technique, water is pumped down the drill stem under high pressure to exit at ports on the chisel-shaped bit. The drill rods and bit are raised and dropped much like the cable tool method, and the water forces the cuttings to the surface as well as helps break the soft formation around the bit. In Missouri, a variation of this method is commonly used to construct domestic wells in the Bootheel area. This method uses small diameter pipe, usually 2 inch, attached to a well screen with an open-bottomed point at its base. A retrievable tube passes through the well screen to the opening at the bottom of the screen. This prevents the water used to jet the well from exiting through the well screen. Rather, it exits through the hole at the bottom of the well screen and creates a void in the soft sediments. The cuttings are carried back to the surface. The pipe and well screen are pushed downward while water is pumped down the well. Wells can easily be constructed to depths greater than 20 ft in soft sediments using this method.

Another type of well often used in the Bootheel or where the sediments are soft and the water table is shallow is the driven well. A typical driven well in Missouri consists of a small diameter, usually 2 inch, well screen with a rugged point at its base. The well point and screen are driven into the ground; short sections of pipe are added as the well advances. In some conditions, the point can be driven by hand with a sledge hammer. In other cases, a heavier slide hammer is used. Driven wells can be installed to depths of more than 30 ft, but are typically much shallower.

Auger rigs and bucket-auger rigs (figure 72) are commonly used to install large-diameter, relatively shallow wells in glacial drift or alluvium. The auger rig typically uses solid stem flight augers to drill in soft, stable materials such as clay-rich drift that is not prone to collapsing during drilling. This type of rig drills a large diameter hole that can be completed with concrete, tile, steel or plastic casing. In many respects, it is the modern day equivalent to the hand-dug glacial drift well that had a low inflow rate, but allowed a large quantity of water to collect in the bore hole.

The auger-bucket rig uses a cylindrical auger-bucket at the end of telescoping square drill pipe. This method, also called rotary bucket drilling, is used to drill large-diameter holes in unconsolidated sediments. Auger-type cutting blades excavate the earth materials and pull them upward into a cylindrical bucket. When the bucket is filled, a cable extracts the bucket and telescoping drill pipe. The bucket is raised above ground, swung to the side by the dumping arm, emptied, and then returned to the drillhole to excavate another load. The buckets are commonly 24 to 36 inches in diameter, and can easily drill 50 to 150 ft depths. When drilling in loose sand formations, water is pumped into the drillhole to maintain water pressure against the formation, much like reverse rotary.

Well drilling in Missouri is regulated by the Missouri Department of Natural Resources through its Division of Geology and Land Survey. Qualified drillers, pump installers, and contractors are issued permits, and only permitted drillers are allowed to construct wells.

TYPES OF WATER WELLS IN MISSOURI

The Missouri Department of Natural Resources divides water supply wells into two broad categories for regulatory purposes—

Figure 72. Bucket-auger drilling rig. Photo by Jim Vandike.

public water supply wells and private water supply wells. Determining which type of well is required for a particular purpose is based on several factors including the number of service connections, the number of people served, the length of time during a year the population is served, the proposed pumping rate, and how the water will be used.

Public water supply wells are divided into three categories—community public water supply wells, transient noncommunity public water supply wells, and nontransient noncommunity public water supply wells. Community public water supply wells are those with 15 or more service connections, or that regularly serve 25 or more people on a year-round basis. Community public water supply wells serve towns, cities, subdivisions, and mobile home parks. They generally serve the same population on a continuous basis, and must be designed by a Registered Professional Engineer.

Transient noncommunity public water supply wells are those with 15 or more service connections, or that regularly serve an average of at least 25 individuals at least 60 days out of the year. They are not designed to serve the same group of people on a regular basis. Transient noncommunity wells are used by such businesses as restaurants, motels, convenience stores and campgrounds. Nontransient noncommunity wells are those with 15 or more service connections, or that regularly serve an average of at least 25 individuals daily at least 60 days out of the year. They, however, can be used to serve the same people on a daily basis. Nontransient noncommunity wells are used to serve schools, factories and other large business. Neither nontransient or transient noncommunity wells are intended to supply a permanent population on a year-round basis. Most transient noncommunity well designs do not require the services of a Registered Professional Engineer. However, regulations require that noncommunity wells constructed for certain uses, such as schools, be designed by a Registered Professional Engineer. All Public Water Supply wells must be drilled by permitted well drillers. Public water supply wells are administered by the Department of Natural Resources' Division of Environmental Quality-Public Drinking Water Program.

The water wells in Missouri that do not fit the criteria used for public water supply wells are considered private wells. Private water supply wells are administered by DNR's Division of Geology and Land Survey. To be considered a private water supply, the well must have fewer than 15 service connections and serve fewer than 25 people daily on a permanent basis. Two types of private wells are used to supply drinking water. The private domestic well can serve from one to three families, and must produce less than 70 gpm. Multiple family wells can serve from four to 14 service connections, but must serve a permanent population of less than 25 people. Generally, any well serving nine or more single-family dwellings, apartment units or condominium units, is assumed to be a public water supply well. Any well designed to produce more than 70 gpm is considered a high-yield well. High-yield private wells are typically used to supply industries or businesses where the water is not being consumed by the employees, or for agricultural irrigation.

WELL CONSTRUCTION IN MISSOURI

Well construction is also regulated by DNR. The Public Drinking Water Program must approve engineering plans and specifications for all community and nontransient noncommunity public water supply wells. They provide general guidelines for constructing transient noncommunity public water supply wells. The Division of Geology and Land Survey assists them by providing casing and total depth information for public water supply wells.

Private well construction standards, as well as those for monitoring wells and heat pump wells, are published by DNR's Division of Geology and Land Survey in Miscellaneous Publication No. 50, ***Missouri Well Construction Rules.*** It is beyond the scope of this report to discuss well construction in detail, but a brief overview of well construction

practices is needed to help show how groundwater in Missouri is obtained and protected. Rules and regulations governing the construction of wells in Missouri are periodically changed. People considering constructing new wells or modifying existing wells should contact DNR to obtain copies of current rules and regulations or guidance documents.

The construction standards used for public and private water wells in Missouri are intended to allow groundwater to be produced while protecting the aquifer and well from potential contaminants. Private water supply wells, which include private domestic wells, multiple family wells, and high yield wells, must be constructed in accordance with regulations developed by the Division of Geology and Land Survey. Regional minimum construction standards have been developed that allow drillers to construct most types of private wells in most areas of the state without having to obtain site-specific construction specifications. There are two exceptions to this: 1) the casing depths for high-yield private wells, which are typically used for irrigation and nonpotable industrial and commercial water supply, must be established by the Division of Geology and Land Survey; 2) private domestic wells drilled within a specific (currently 0.25 mi) distance from most of the large lakes in the state must be cased at least 50 ft below lake bottom. Lake-depth information is normally not readily available to well drillers, and casing depths for these wells are generally supplied on a case by case basis by the Division of Geology and Land Survey.

PUBLIC WATER SUPPLY WELLS DRILLED INTO BEDROCK

Public water supply wells drilled in areas where bedrock is competent, such as the Salem and Springfield plateaus and the freshwater area of northeast Missouri, typically consist of an unlined, open borehole below the casing. To construct these wells, the driller generally begins by drilling a relatively large-diameter hole through the soil and weathered bedrock until competent bedrock is reached. This hole is generally 8 inches in diameter larger than the proposed finished well diameter. The driller installs surface casing into this hole. The surface casing is 4 inches in diameter larger than the permanent production casing, and its purpose is to prevent loose soil material and weathered rock from caving into the drillhole. After the surface casing is installed, the driller typically drills a pilot hole to below the proposed casing depth of the well. The cuttings are transported to the Division of Geology and Land Survey where they are examined by a geologist who determines if a suitable casing point has been reached. When an acceptable casing point has been reached, the driller reams the pilot hole to a diameter at least a nominal 4 inches greater than that of the casing. For example, if a finished well diameter of 12 inches is needed and surface casing is required, the surface casing will be 16 inches in diameter and will be set into a drillhole that is 20 inches in diameter. The 12 inch diameter casing will be set into a hole at least 16 inches in diameter.

Casing is installed into the drillhole and the open area between the wall of the drillhole and the outside of the casing. This is called the *annular space* and is completely filled with neat cement grout. Neat cement is a mixture of Portland cement and water. A maximum of about 6 gallons of water is used per 94 lb sack of cement. No sand or gravel is used, although small amounts of bentonite are sometimes mixed with the neat cement grout to counteract shrinkage or increase viscosity. The casing is generally steel weighing 19 lb/ft for 6-inch diameter, proportionally heavier for larger diameter casing. Community public water supply wells must be pressure grouted; the neat cement grout must be pumped down the inside of the casing, and forced back to the surface on the outside of the casing. Under some conditions, noncommunity public water supply wells can be grouted using a *tremie pipe*. With this technique, a small-diameter pipe is installed outside of the casing. Grout is pumped down the small-diameter pipe and forced back to the surface, filling the annular space. Sealing the casing full length with neat cement helps ensure that the well will not be

affected by surface water or shallow groundwater that is more likely to contain bacteria or other contaminants.

The length of casing needed for public water supply wells varies considerably with geologic conditions. In a few areas, as little as 150 ft of casing is used for transient noncommunity wells. Community public water supply wells generally have the highest construction standards. Casing lengths in these wells vary from about 300 ft to more than 900 ft, depending on the characteristics of the rock, water quality and other considerations. These wells are constructed to prevent surface water and shallow groundwater from impacting the well. Thus, most community public water supply bedrock wells require no water treatment, including chlorination.

After the grout is allowed to cure, generally a minimum of 72 hours, a drill bit slightly smaller in diameter than the casing is used to complete the hole to total depth. The total depth of the well depends on the volume of water desired and water quality. In general, there is little or no reason to drill deeper than where the necessary volume of water is obtained. However, in areas where high groundwater use increases the likelihood of groundwater-level declines, wells should be drilled somewhat deeper to allow for drawdown. Figure 73 shows typical construction of community public water supply wells in the St. Francois Mountains, Salem Plateau, and Springfield Plateau groundwater provinces.

Private Water Supply Wells Drilled into Bedrock

The private domestic well can serve up to three families, but is generally designed to serve a single family or dwelling. The minimum length of casing required varies with the area. In the Ozarks, current standards require at least 80 ft of casing set a minimum of 30 ft into unweathered rock. Less casing may be required in the western, northwestern and northeastern parts of the state, while more casing is necessary near large lakes and in the Springfield area of Greene and northern Christian counties. There are a variety of approved techniques that can be used to grout casing in private wells. Some of the techniques can be used only when the casing is less than a certain length, or in certain areas. Neat cement and bentonite are the materials used to seal the casing in most private wells.

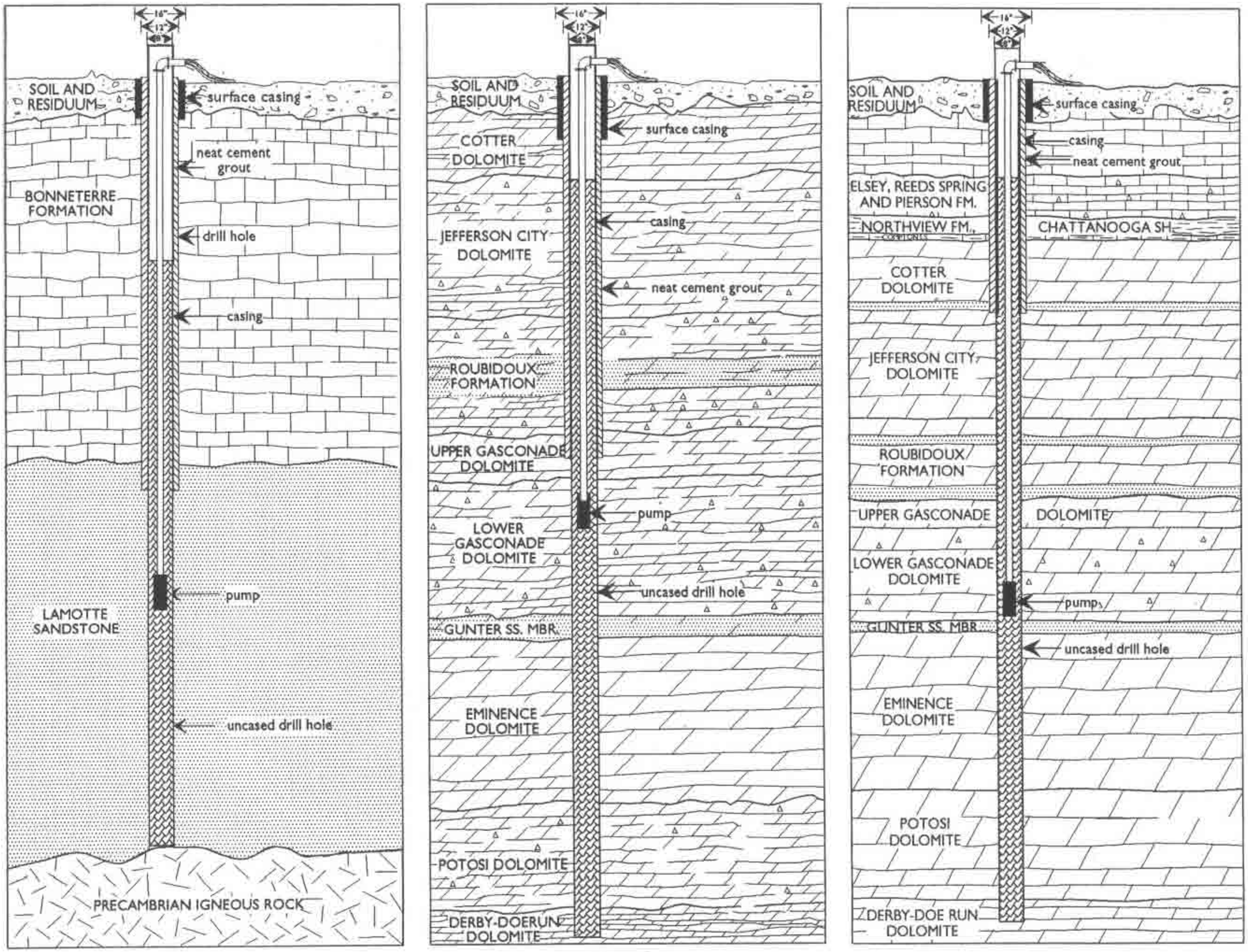
Multiple family wells are intended to help fill the gap between private domestic wells and community public water supply wells. The multiple family well shares construction similarities with both the community and private wells. It can serve up to 14 service connections, but must not serve more than an average of 25 people on a permanent basis. Generally, any well serving more than eight families will likely exceed the 25 person limit, and is thus considered a public water supply. The length of casing required for a multiple family well is determined by region, and is the same as the minimum casing length for a private domestic well in the same region. The casing is lighter in weight (minimum 13 lb/ft for 6-inch diameter) than a public water supply well, but it must be set into a drill hole 4 inches in diameter greater than the casing and be grouted full length using pressure grouting or tremie pipe.

Bedrock irrigation wells are constructed similar to public water supply wells. The weight of casing used in them is greater than that for private wells, and they too require full length grouting. Also, the casing depths of irrigation wells are established on a case by case basis by the Division of Geology and Land Survey.

Figure 74 shows the construction of typical private bedrock wells in the Salem Plateau and Springfield Plateau groundwater provinces.

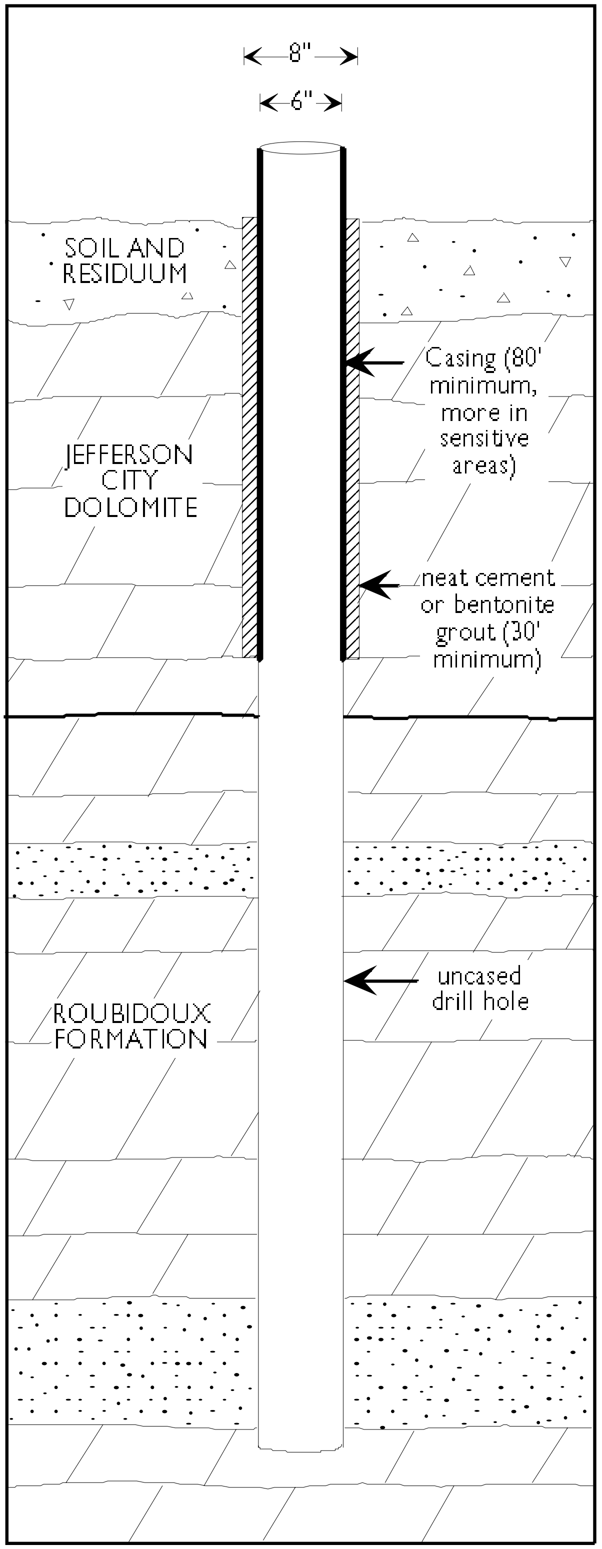
Public and Private Water Supply Wells Drilled into Unconsolidated Materials

Wells drilled into alluvium, glacial drift, and other unconsolidated deposits are constructed much differently than bedrock wells. In unconsolidated deposits, wells typically contain a well screen at the bottom of the casing that is set opposite of water-productive materials. Only a few feet of screen may be necessary for a private, low-yield well. High-

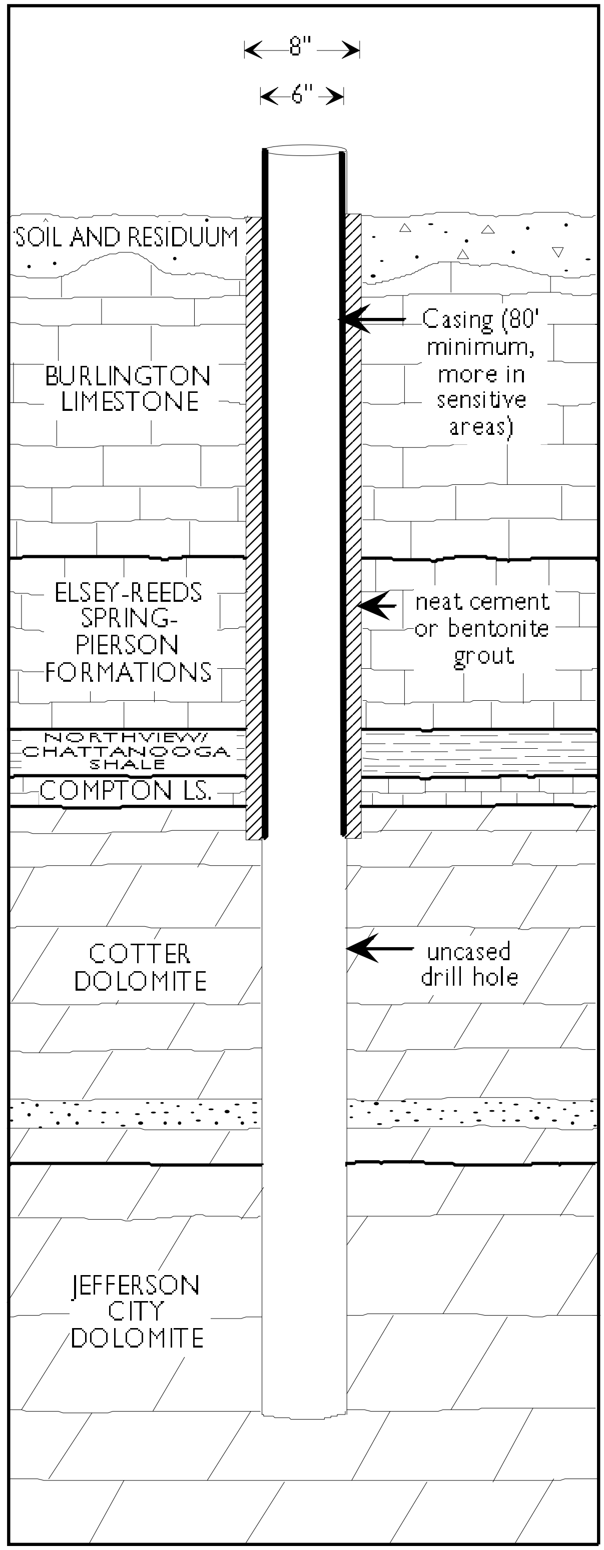


St. Francois Mountains **Salem Plateau** **Springfield Plateau**

Figure 73. Typical public water-supply well construction in the St. Francois Mountains, Salem Plateau and Springfield Plateau groundwater provinces.



Salem Plateau groundwater province



Springfield Plateau groundwater province

Figure 74. Typical construction of private water-supply wells in the Salem Plateau and Springfield Plateau groundwater provinces.

yield irrigation or public water supply wells may require considerably greater lengths of well screen. The screen has openings that allow water to enter the well while excluding most of the sediment. The size of the screen openings can be determined by analyzing sand samples collected from a test hole. The screen is generally sized to allow the fine particles to pass through it while the well is being developed by pumping, but will not allow most of the coarser materials to pass through it. This develops a natural gravel pack outside of the well screen. In some cases, an artificial gravel pack is used. Here, the screen is sized depending on the size of gravel or sand used for the artificial gravel pack which is placed in the well outside of the well screen. Figure 75 shows general construction of public and private wells drilled into unconsolidated alluvial materials.

Large-diameter augered wells, cased with tile or concrete casing, are typically used in the low-permeability glacial drift of northeast and northwest Missouri. These wells do not typically contain a well screen, per se. Water enters them through the small gaps between the casing joints. The inflow rates of such wells are typically less than 3 gpm, but the large diameter of the wells allows considerable water to be stored in the well bore, enough water to meet at least modest household demands (Figure 76).

WELL PLUGGING

Wells, like most man-made devices, have a useful life beyond which they either fail or require extensive repair. If repairs can be made, the useful life of the well can be extended. But if the well becomes contaminated, is no longer used, or falls into such need of repair that it is not feasible to use as a water-supply source, it should be plugged. The proper plugging of abandoned wells has always been advised when the wells are no longer needed or cannot be used, but with passage of the Water Well Drillers Act in 1985 and its revision in 1991, it is now law (RSMo 256.615).

Different types of wells require different techniques of plugging. For relatively small-diameter drilled wells such as those most commonly used throughout the state, the drill hole can be filled from the bottom to 50 ft below the casing with washed, disinfected gravel, and from 50 ft below the bottom of the casing to about 3 ft below land surface with neat cement or bentonite. The casing should be cut-off about 3 ft below ground to prevent it from interfering with surface activities. If there is more than a few feet of water standing in the well above the gravel fill, then a tremie pipe should be used to place the neat cement. Chipped bentonite can be used to fill the well if it is poured in slowly, at a rate of about one sack each three minutes, and the fine particles are removed. The above apply when the well is not contaminated by anything other than, perhaps, bacteria. More seriously contaminated wells, such as those containing organic chemicals, gasoline or other similar substances, must be plugged bottom to top with neat cement or bentonite slurry introduced through tremie pipe to ensure the contaminants will not be spread vertically through the aquifer.

Large-diameter augered or dug wells like those widely used in northern Missouri present a different type of risk. They become sites of tragedy if a child or other unsuspecting person or animal falls into an abandoned well and drowns. These wells can be plugged easily and inexpensively using a variety of materials including gravel or sand in the lower part and locally-derived clay, agricultural lime, or other inert, low-permeability material in the upper part.

Unplugged wells are a common source of groundwater contamination, and can be an expensive liability. There are numerous cases in Missouri where unplugged abandoned wells allowed groundwater contamination to occur. The plugging of wells must be viewed as an investment for the future. In many cases, the continued good quality of groundwater resources depends on it.

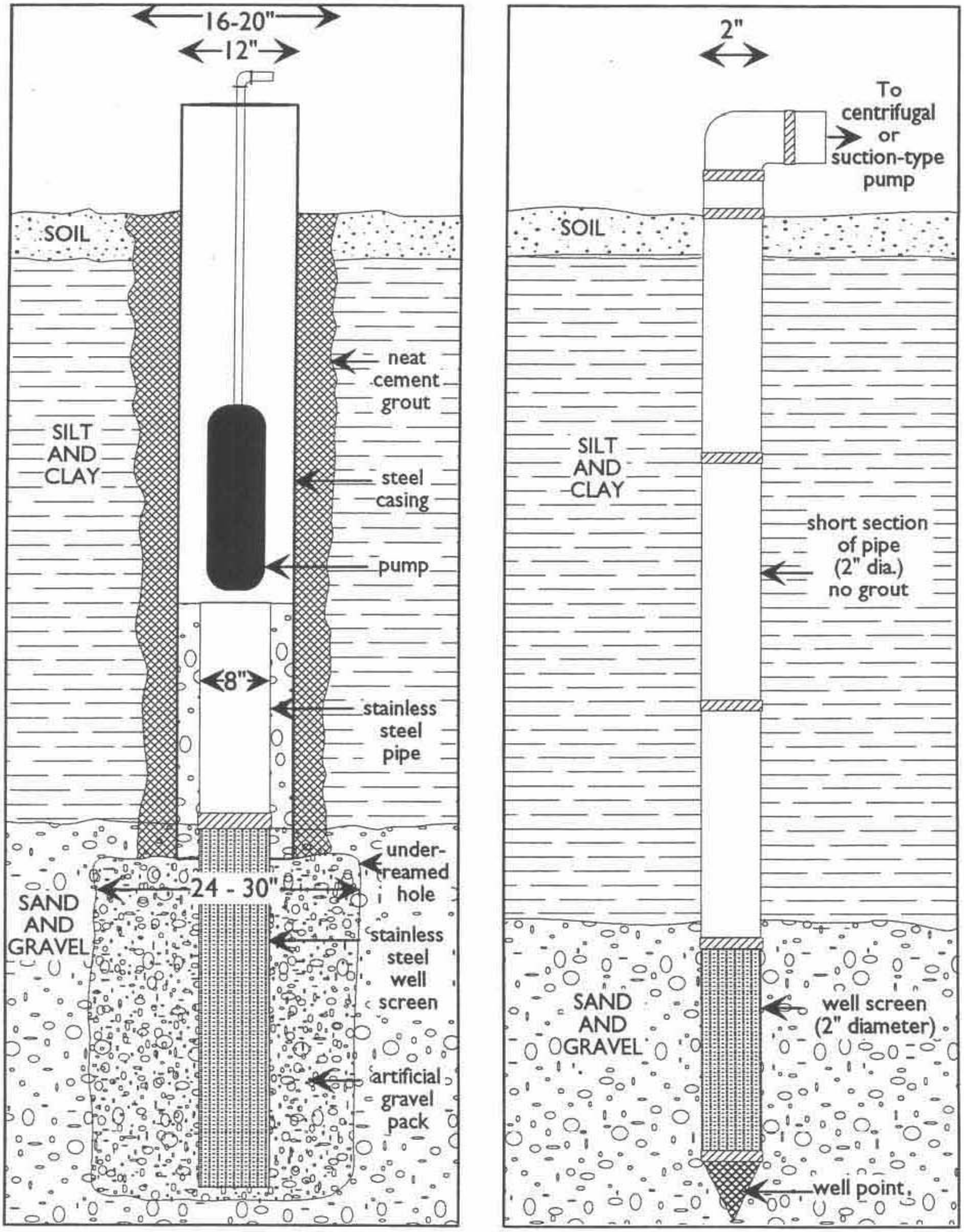


Figure 75. Typical construction used for public and private water supply wells in alluvial deposits.

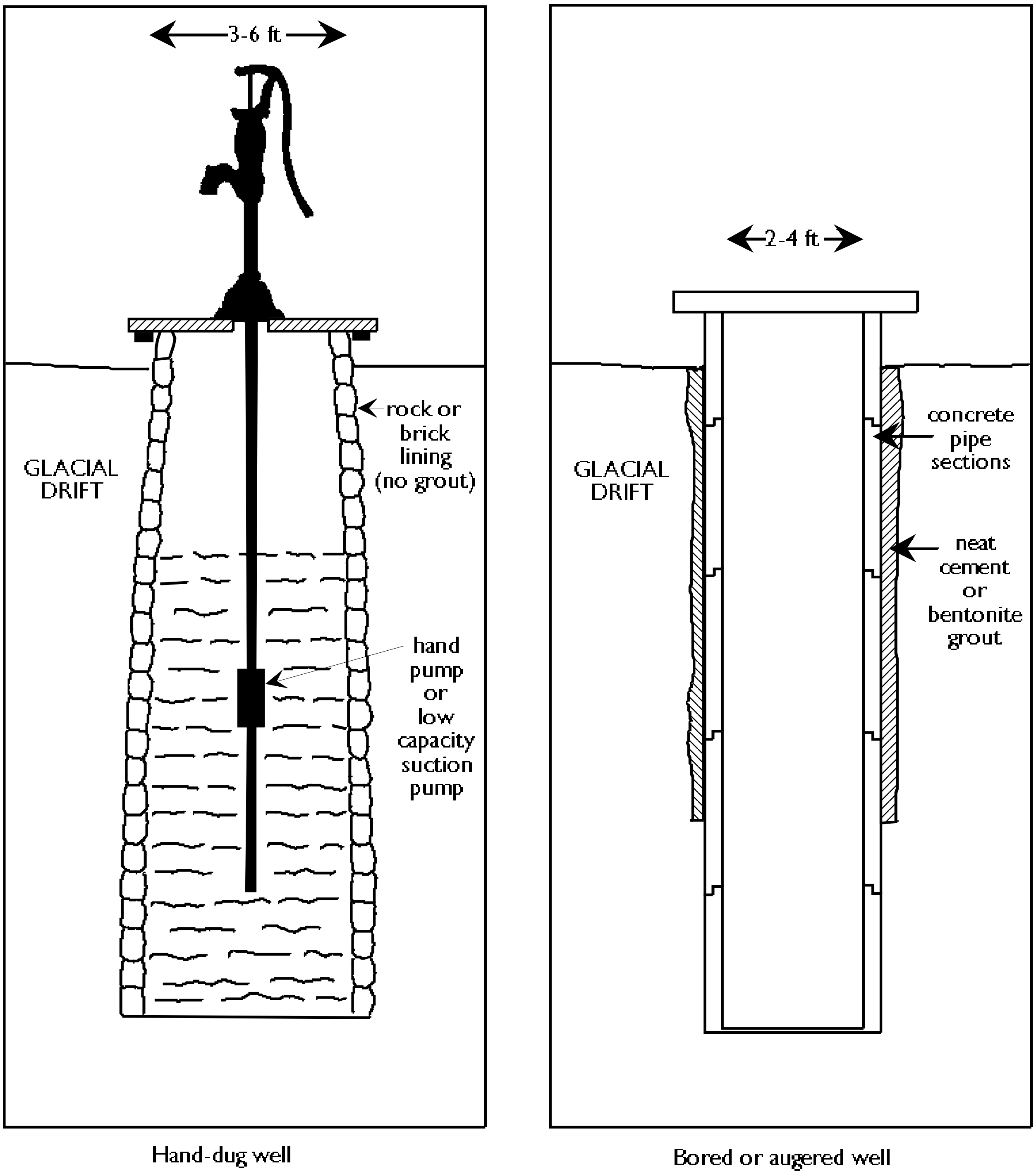


Figure 76. Typical construction used for private hand-dug and augered glacial drift wells.

SUMMARY AND CONCLUSIONS

This report is an overview of the groundwater resources of Missouri. It is not intended to be a detailed groundwater assessment or a description of site-specific groundwater problems. Rather, it is a general evaluation of the groundwater resources of a state that has very diverse, natural geologic and hydrologic conditions.

Since Missouri is so geologically and hydrologically diverse, the report divides the state into seven groundwater provinces and two subprovinces. The boundaries of the provinces are based on differences in physiography, the geologic character of the water-bearing rock formations, differences in the hydrology of the groundwater system, differences in the chemical quality of the groundwater, and the overall vulnerability of the aquifers to contamination. The provinces are the St. Francois Mountains, the Salem Plateau, the Springfield Plateau, the Southeastern Lowlands, Northwestern Missouri, Northeastern Missouri, and West-Central Missouri. The two subprovinces are the Mississippi River alluvium and the Missouri River alluvium. In each of the major groundwater provinces there may be from one to four or more aquifers.

The groundwater resource base in Missouri is one of its most important natural resources. There are more than a dozen major aquifers in Missouri whose depths vary from a few feet below land surface to more than 2,000 feet, and whose areal extents range from a few hundred square miles for localized channel sandstone deposits, to that of the Ozark aquifer, which underlies more than 35,000 square miles of southern Missouri.

Groundwater in Missouri originates as, and is replenished by, precipitation. Shallow aquifers separated from land surface by only a few feet of relatively permeable materials receive considerable recharge very quickly after precipitation occurs. Deeper aquifers that are overlain by low-permeability strata, or aquitards, are generally recharged much more slowly. Groundwater recharge rates vary widely, from less than an inch per year in parts of northern and west-central Missouri, to more than 12 inches in certain karst areas in southeastern Missouri.

As part of this report, groundwater storage estimates were made for each of Missouri's major aquifers on a county by county basis. These estimates relied on many data sources, but basically used average saturated aquifer thickness for each aquifer within a particular county, and assumed reasonable specific yields or effective porosities. It is difficult to assess their accuracy, but the estimations are based on the best regional information available.

Missouri's greatest groundwater resources lie south of the Missouri River. The Salem Plateau groundwater province contains the greatest groundwater resources. Thick dolomite and sandstone formations of Cambrian- and Ordovician-age underlie the area, and comprise the Ozark and St. Francois aquifers. Part of the Missouri River alluvial aquifer lying south of the river is also included in this province. In the Salem Plateau groundwater

province, these aquifers contain approximately 233 trillion gallons, or about 46.6 percent of the usable groundwater in the state. The St. Francois and Ozark aquifers extend to the west into the Springfield Plateau groundwater province, where they are overlain by several hundred feet of Mississippian-age limestones that comprise the Springfield Plateau aquifer. Groundwater storage in this province is estimated to be about 122.5 trillion gallons, or about 24.5 percent of the usable groundwater in Missouri.

Considering its size, the Southeast Lowlands groundwater province contains the greatest volume of groundwater per unit area. Parts of the St. Francois and Ozark aquifers are usable in the northwestern part of this province. However, most of the groundwater is contained in thick deposits of shallow alluvium and deeper Tertiary- and Cretaceous-age sands. About 15.2 percent of Missouri's groundwater, an estimated 75.8 trillion gallons, are found in this southeastern corner of Missouri.

The remaining groundwater provinces south of the Missouri River contain more modest reserves of usable groundwater. In the St. Francois Mountains groundwater province, the St. Francois aquifer is typically the only source of appreciable quantities of groundwater except near its outer margins where the Potosi Dolomite may be thick enough to yield some water. Much of the area is directly underlain by Precambrian-age igneous rocks that are essentially impermeable and store or yield little water. This area contains less than 0.2 percent of Missouri's groundwater—an estimated 919 billion gallons.

The West-Central Missouri groundwater province fares somewhat better. The freshwater-salinewater transition zone forms the boundary between the Springfield Plateau and West-Central Missouri groundwater provinces. Aquifers in Mississippian-, Ordovician-, and Cambrian-age rock south off this transition zone yield good-quality water, but the same aquifers north of the transition zone contain highly mineralized water. The northern part of this province borders the Missouri River and includes the Missouri River alluvium. Buried alluvial and glacial drift channels paralleling the river help to locally increase its groundwater resource base. Most of the area is underlain by relatively impermeable Pennsylvanian-age sedimentary strata that yield, at best, only meager volumes of marginal quality water. Groundwater storage estimates for this region are about 1.2 trillion gallons, or about 0.24 percent of the usable groundwater in Missouri. Cumulatively, the groundwater provinces south of the Missouri River contain about 86.7 percent of the states usable groundwater.

The remaining 13.3 percent of Missouri's groundwater occurs in the northern part of the state. In the Northwestern Missouri groundwater province, the alluvial deposits along the Missouri River and thick glacial materials form its most significant aquifers. This area contains an estimated 10.9 trillion gallons of groundwater, or about 2.2 percent of the groundwater in Missouri. Deeper bedrock aquifers contain vast quantities of water, but the water is too highly mineralized to be considered potable.

Groundwater resources in the Northeastern Missouri groundwater province are much more varied. Glacial drift also underlies much of this area, but is generally thinner and finer-grained than in northwest Missouri. Alluvial deposits bordering the Missouri and Mississippi rivers are important aquifers. Mississippian-age limestones yield modest amounts of marginal quality water in the northern part of the region, while south of the freshwater-salinewater transition zone, Mississippian, Ordovician, and Cambrian limestones, dolomites, and sandstones are important aquifers. This province contains about 11.1 percent of Missouri's potable groundwater, a volume of about 55.8 trillion gallons.

Figure 77 graphically depicts potable groundwater storage estimates for each county in the state. As can be seen by the illustration, there are large differences in groundwater storage volumes between counties and between groundwater provinces. Many of the northern and west-central Missouri counties and several in the St. Francois Mountains have relatively poor groundwater resources. How-

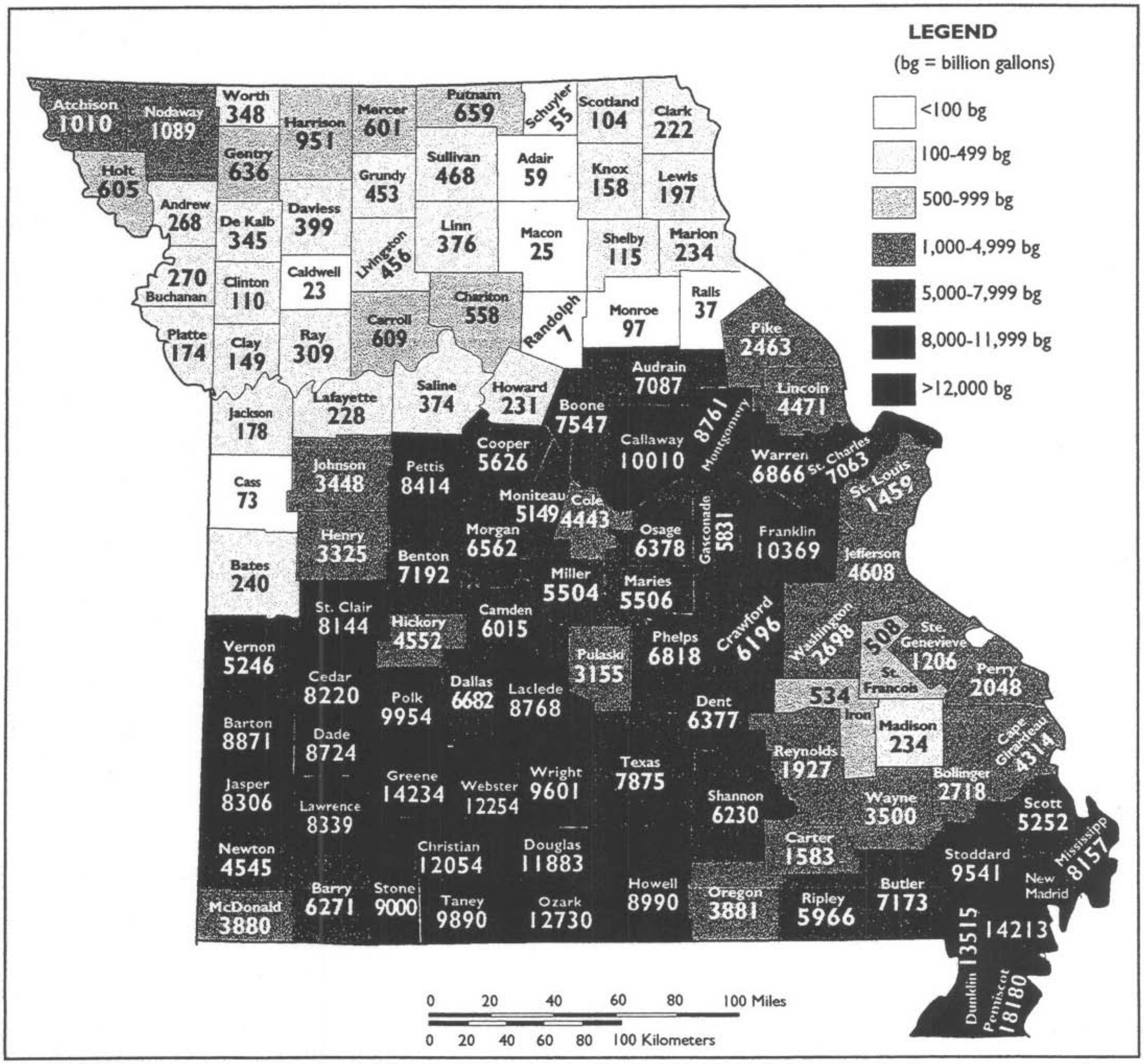


Figure 77. Potable groundwater storage by county for Missouri.

ever, there are probably no places in Missouri where the groundwater resources, when combined with surface water resources, cannot meet water demands.

Statewide groundwater storage estimates show that aquifers in Missouri contain slightly more than 500 trillion gallons of usable quality groundwater. This is enough water to cover the state to a depth of over 34 feet, or supply each of its 5.1 million residents 100 gallons of water per day for nearly 2,700 years. It is equivalent to the volume of rainfall that Missouri normally receives in nearly an 11-year period. The above comparisons are useful for visualizing the magnitude of this resource, but do not reflect how groundwater should be managed. For example, a per capita water use of 100 gallons per day is commonly assumed when estimating water use for small towns, public water supply districts, and even private water supplies. But this is but a small fraction of the total amount of water needed for our society. Tremendous volumes of water are used for industrial and commercial purposes, agricultural irrigation, power production and other purposes. It must be remembered that in order to remain a renewable resource, the net use of groundwater must not exceed its net recharge.

The volume of groundwater that Missouri has available is so staggering that it is difficult to imagine how such a resource could ever be depleted. In a few areas of the state it would be extremely difficult to use all of the available groundwater. However, groundwater resources are not evenly distributed. Neither is groundwater use. Production from a particular aquifer may be minimal throughout most of a county, but very high in a few square-mile area due to municipal, industrial or agricultural needs. It is quite possible to overuse an aquifer in one area, while the same aquifer a few miles away is essentially unused.

A commonly asked question is how much water can be safely removed from a particular aquifer? Unfortunately, such a question is much more easily asked than answered. Ideally, the volume of water in Missouri aquifers should be kept relatively constant. If more water is removed from the aquifer than is replenished by recharge, groundwater levels begin to decline. As depth to groundwater increases, the costs of new well construction increases because wells will need to be drilled deeper. Existing wells may have to be deepened and equipped with larger pumps, and pumping costs will increase because the water is being pumped against a greater head pressure. Todd (1959) defined the *safe yield* of a groundwater basin as the amount of water that can be withdrawn from it annually without producing an undesired result. Any withdrawal in excess of safe yield is termed an *overdraft*. An undesired result could be a decline in groundwater level, a change in water quality, or other consequence. Groundwater overdrafts can generally be tolerated only when they are a short-term occurrence. For instance, groundwater overdrafts often occur during extended droughts when heavier than normal demands are placed on groundwater resources. This is probably acceptable so long as groundwater levels are allowed to recover when precipitation returns to normal levels.

Driscoll (1987) states that the wise use of groundwater involves three general principles: (1) development of technologies that will enhance the storage capacity of groundwater reservoirs, (2) protection of groundwater quality, and (3) utilization of groundwater resources for their highest or most valuable use to society. Private water-supply users, farmers, cities and others can probably do little about the first of the above principles, although considerable research has been conducted on enhancing aquifer storage capacity, improving well yields, and replenishing aquifers through artifical recharge. Existing state and federal laws have done much to addres the second principle. All users of water should seriously consider the third factor before deciding on a water supply source. If their water-use demands will appreciably affect groundwater levels or cause other undesired changes in the aquifer, then it would be prudent for them to explore other water-supply options.

A sizeable percentage of Missouri's usable groundwater is in aquifers that are relatively expensive to exploit. For example, the St. Francois aquifer in the St. Francois Mountains area is fairly shallow. However, in southwestern Missouri it may be more than 2,000 ft in the subsurface. So, even though it is considered a groundwater resource, it is mostly unused because shallower, more productive aquifers are available throughout much of the Ozarks.

If groundwater resources were evenly distributed across the state, then each square mile of Missouri would contain about 7.17 billion gallons of water beneath it. Unfortunately, this is not the case. Average groundwater availability in Missouri north of the Missouri River is only about 2.8 billion gallons per square mile, while that of the southern part of is much higher, about 9.5 billion gallons per square mile. Locally, groundwater storage in northern Missouri can be much less than the average. Thus, a resource that many take for granted in the southern part of the state is considered a precious commodity in the north.

Another factor to consider is that the quality of water is a most important consideration in determining its potential use. Groundwater contamination due to improper waste disposal, inappropriate land use, accidental spills, and other factors can cause a usable aquifer to essentially become unusable, at least for an extended period of time.

Although groundwater is a vast resource in Missouri, it is also a finite resource. Unlike many western states where groundwater recharge rates are so low that groundwater is not replenished, many Missouri aquifers receive considerable recharge during most years. With proper management and protection, Missouri's groundwater resources can continue to provide high-quality water to meet many of Missouri's domestic, municipal, industrial, agricultural, and recreational needs. Avoiding aquifer over-use and protecting groundwater from contaminants are two ways to best ensure its continued availability for future generations.

Missouri statutes and regulations generally provide for adequate protection of water quality. However, there are few if any laws that regulate the volume of water that is used for a particular purpose. (For a more complete assessment of water law in Missouri, the reader is referred to ***Missouri Water Law,*** *Missouri State Water Plan Series Volume VII* [Gaffney and others, 1998]). If groundwater use exceeds recharge, water-level declines will occur, and disputes will likely arise. Currently, these types of disputes, though uncommon, must be addressed in the courts through civil suits. As population and water use increases, there will be even greater demands placed on groundwater resources, and the incidence of water-use conflicts will probably increase. Further legislation may be needed in the future to prevent overuse of groundwater resources, or to define which uses should receive priority, especially during periods of drought or where groundwater demands greatly exceed resource capacity.

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Well Owner	County	Location Sec. T. R.	Yield (gpm)	Transmissivity gal/day/ft	Storage Coefficient (dimensionless)
Lost Valley Hatchery Well #1	Benton	04 40N 22W	450	4,604	$1.6 X 10^{-4}$
City of Camdenton Well #6	Camden	25 38N 17W	500	3,568	NA
Church Farm #7	Cole	18 45N 12W	100	573	$2.0 X 10^{-4}$
Cole Co. PWSD #1 Well #3	Cole	18 44N 12W	570	16,217	$1.6 X 10^{-3}$
MO State Penitentiary Well #2	Cole	08 44N 11W	260	5,280	$1.5 X 10^{-3}$
City of Cuba Well #4	Crawford	30 39N 04W	300	7,900	$1.0 X 10^{-3}$
City of Buffalo Well #2	Dallas	23 34N 20W	350	6,160	$1.5 X 10^{-3}$
Dent Co. PWSD Well # 1	Dent	29 34N 05W	150	1,460	NA
City of Sullivan Well #10	Franklin	10 40N 02W	200	2,400	NA
City of Union Well #2	Franklin	27 43N 01W	608	34,151	NA
City of Hermann Well #3	Gasconade	26 46N 05W	350	1,270	$3.0 X 10^{-3}$
City of West Plains Well #8	Howell	18 24N 08W	420	2,464	NA
Jefferson Co. PWSD #7 Well B	Jefferson	26 41N 04E	323	101,000	$6.6 X 10^{-3}$
Laclede Co. PWSD #1 Well #3	Laclede	12 33N 17W	140	3,800	$2.0 X 10^{-4}$
Laclede Co. PWSD #3 Well #6	Laclede	07 33N 18W	225	2,970	NA
City of Belle	Maries	21 41N 07W	145	2,000	$1.0 X 10^{-3}$
Ozark Co. PWSD #1	Ozark	18 22N 15W	150	5,800	$2.0 X 10^{-3}$
Tyson Foods Well #2	Pettis	22 46N 22W	950	7,838	$2.0 X 10^{-3}$
Rolla Industrial Park Well #2	Phelps	32 38N 07W	500	19,000	$9.0 X 10^{-9}$
City of St. James Well #4	Phelps	19 38N 06W	550	12,000	$2.5 X 10^{-4}$
City of Rolla Well #13	Phelps	07 37N 07W	802	13,233	NA
Ft. Leonard Wood Well #2	Pulaski	09 35N 11W	200	2,640	NA
Ft. Leonard Wood Well # 8	Pulaski	04 35N 11W	250	1,375	$1.2 X 10^{-4}$
Eastern MO Corr. Fac. Well #2	St. Louis	05 43N 03E	350	27,600	NA
Texas Co. PWSD #1 Well #2	Texas	27 33N 11W	180	2,500	NA
City of Licking Well #3	Texas	07 32N 08W	300	4,300	$3.0 X 10^{-4}$
Cabool Industrial Park	Texas	10 28N 11W	200	4,800	$4.0 X 10^{-3}$

By CODY MROCZKA / CMROCZKA@LAKESUNONLINE.COM

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Mayor John McNabb said discussions of extending the runway an extra thousand feet had been going on since before 2007, prior to when he got involved in city government. Now, with all 49 hangars at the airport filled and with a waiting list forming, the time appears to be ripe for expansion.

Camdenton City Administrator Jeff Hancock knows a thing or two about airports. Before he was in City Hall, Hancock was in charge of almost a half dozen of them ranging in different sizes around the Midwest.

Although Camdenton Memorial Airport has had its share of controversies in the past — an original runway extension to 4,000 feet in 2002, a name change in 2014 and in the last couple of years the Veteran's Memorial Monument project, just completed last week — Hancock believes the future of the airport is bright. The the city has one of the finest Fixed Based Operator (FBO) in the business in Corey Luewerke and Lake Aviation Center, Hancock said.

"We're working hard to do that extension of the runway, going from 4,000 to 5,000 feet, it has been our biggest focus," Hancock said. "In my opinion, it is one of the biggest economical development things at the Lake of the Ozarks."

Mayor John McNabb said discussions of extending the runway an extra thousand feet had been going on since before 2007, prior to when he got involved in city government. Now, with all 49 hangars at the airport filled and with a waiting list forming, the time appears to be ripe for expansion.

"It was out there," McNabb said, referring to those talks. "But there really hadn't been a lot done with it. It's going to allow corporate jets to fly in and out. There's so many corporations who won't even consider expanding into an area unless they can have corporate fly in."

The proposed extension project of the runway at the 192-acre airport, located off of Old South 5 and about three miles from the center of the city, was approved by Missouri Department of Transportation Aviation and the Federal Aviation Administration in 2012 using a 10-percent local match funding agreement - meaning state and federal officials would supply 90-percent of the cost while the city would cover the remaining 10-percent.

The project is estimated to cost roughly $7 million dollars, but that number could change.

However, this didn't happen by chance. Airport funding is notoriously difficult to obtain, and even when projects like this are approved, as in this case, the money still has to be allocated, budgeted and can be withheld for years until obligations are met.

Luewerke, owner of Lake Aviation Center, said when he got involved with the process in 2002 while flying around the Lake region as a small commercial pilot, MoDOT officials were against the project.

“Even back then before the city was looking for an FBO, they knew we needed a bigger runway to bring in corporate jets. We knew we needed a better weather system, needed better approaches,” Luewerke, whose company has been the FBO since 2007, said. “When we first approached MoDOT, we were told it wasn’t needed. It took a pretty intense letter-writing campaign, and more importantly the drive time study which was necessary for approval.”

Luewerke said officials in Jefferson City thought Lee C. Fine airport, with a 6,500-foot runway and in close proximity to Osage Beach, was serviceable enough for the region. However, when one MoDOT official was in town for a conference, Luewerke drove him out to Lee C. Fine for a demonstration.

“They were shocked, almost a 30-minute drive from Lake Ozark on a two-lane, winding road,” he said. “It really didn’t serve all the needs of the whole Lake area, if you’re thinking about Camdenton, Sunrise Beach.”

Around the time Luewerke’s company took over plans were in place to begin updating the airport dedicated in 1949 and renovated in the 1990′s before additions took place in the early 2000s.

In 2008 and 2009, the airport installed an Automated Airport Weather Station (AWOS), making it legal for corporate jets to land and takeoff, added precision approaches using vertical GPS to the runways, and installed a wildlife fence to prevent mainly deer from running out on the runway, which Luewerke said happened about three times before, about one every year, and zero times since the fence has gone up.

“The big one is the runway expansion. It’s the hardest, most expensive, of course the land acquisition. That’s always a touchy subject,” he said. “The city has worked very hard on trying to provide fair market value for property and make everybody happy. I believe all the deals have been at least verbally agreed on.”

The property purchases and easement agreements Luewerke is referring to are in effect what has held the project up until recently. If you follow the Board of Alderman regular meetings you’ll notice the city has been having a quite few closed session real estate meetings in the last couple of months, most have been related to purchasing or leasing property needed for the runway extension.

“We’ve already gotten the big piece of property we needed and recently found out there was another property we don’t need. For the dirt work, we’re just about ready. There was some airspace issues the FAA was concerned with that we’ve addressed, so we’re getting there,” Hancock said. “There were 11 property owners, we’ve got about half so far. Last meeting we had Reinhold, this meeting we’re going to have B&N Manufacturing, the following meeting, the second one in September we hope to have another.”

It has taken several years for the city to acquire the necessary land to begin dirt work, but a good sign occurred when state and federal officials funded the environmental impact study last year to keep the project progressing.

“The project has been put on the STIP, they’ve agreed it needs to be done. Now the question is whether the money is available,” Luewerke said. “They’ve frozen a lot of new projects and are more concerned with

maintaining what they already have, but we’ve been told we’re still getting the go-ahead because the project had already been approved.”

Hancock said this is the nature of the airport business.

“When they do federal and state planning and look at all the numbers, they figure out what the demand is before okaying it,” Hancock said. “They look at which is appropriate to meet that need and demand and they chose Camdenton. It is centrally located and does have a great transportation system with the two highways. With that being said, when the economy goes up the airports go up, when the economy goes down, it’s really the last in the boat.”

With just about all the land necessary to begin dirt work, Hancock said the city is hoping to follow this tentative timeline:

2017-2018 — Bid out dirt work

2018-2019 — Construct runway extension

*2018-2019 — Possible extension to taxiway, possible ramp overlay, possible additional resources and services to offer

“The runway extension is the big piece. It’s the required piece to bring us more traffic,” Luewerke said. “When you start bringing more traffic, you want to up the services and you want to improve the resources at the rest of the airport as well.”

United States Environmental Protection Agency | Office of Research and Development | Office of Solid Waste and Emergency Response | EPA/540/S-94/505 October 1994

EPA Ground Water Issue

Natural Attenuation of Hexavalent Chromium in Ground Water and Soils

Carl D. Palmer* and Robert W. Puls**

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange up-to-date information related to ground-water remediation at Superfund sites. One of the major issues of concern to the Forum is the natural attenuation of contaminants in the subsurface. This paper focuses on the natural attenuation of hexavalent chromium in soil and ground water. Much of the interest of natural attenuation of chromium stems from the great expense of remediating chromium-contaminated sites. Some of the issues discussed include the conditions that must be present for the necessary processes to occur, changes in toxicity, the time required for target concentrations to be reached, and assurances that chromium in the reduced state will remain immobile.

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Introduction

Chromium is an important industrial metal used in diverse products and processes (Nriagu, 1988a,b). At many locations, Cr has been released to the environment via leakage, poor storage, or improper disposal practices (Palmer and Wittbrodt, 1991; Calder, 1988). Within the environment, Cr is found primarily in two oxidation states: Cr(VI) and Cr(III). Cr(VI) is relatively mobile in the environment and is acutely toxic, mutagenic (Bianchi et al., 1983; Beyersmann et al., 1984; Bonatti et al., 1976; Paschin et al., 1983), teratogenic (Abbasi and Soni, 1984), and carcinogenic (Mancuso and Hueper, 1951; Mancuso, 1951; Waterhouse, 1975; Yassi and Nieboer, 1988; Ono, 1988). In contrast, Cr(III) has relatively low toxicity (van Weerelt et al., 1984) and is immobile under moderately alkaline to slightly acidic conditions.

Concerns about the impact of chromium on human health and the environment require an evaluation of the potential risk of chromium entering the ground water flow system and being transported beyond compliance boundaries. At sites where such potential exists, active remedial measures such as excavation or pump-and-treat have been undertaken. Experience at sites where pump-and-treat remediation of chromium-contaminated ground water is currently under way suggests that, although it is feasible to remove high levels of chromium from the subsurface, as concentrations decrease it becomes more difficult to remove the remaining chromium (Wittbrodt and Palmer, 1992). While several new remedial technologies are being investigated, there is still concern about the cost of such remediation technology; and, at many sites, there is a debate about the need for expensive remediation.

Researchers have identified natural reductants that can transform the more toxic hexavalent form of chromium to the less toxic trivalent form. Under alkaline to slightly acidic conditions, this Cr(III) precipitates as a fairly insoluble hydroxide, thereby immobilizing it within the soil. Such **"natural attenuation"** of hexavalent chromium is of great interest because it suggests that strict water-quality standards do not have to be attained everywhere within and beneath the

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site. If natural attenuation does occur, pump-and-treat remediation could desist after the most contaminated ground water has been removed, even if the maximum contaminant level (MCL) has not been achieved. Under certain circumstances, expensive remedial measures may not even be necessary.

In this paper, what is known about the transformation of chromium in the subsurface is explored. This is an attempt to identify conditions where it is most likely to occur, and describe soil tests that can assist in determining the likelihood of natural attenuation of Cr(VI) in soils.

The Geochemistry of Chromium

Chromium exists in oxidation states ranging from +6 to -2, however, only the +6 and +3 oxidation states are commonly encountered in the environment. Cr(VI) exists in solution as monomeric ions $H_2CrO_4^0$, $HCrO_4^-$ (bichromate), and CrO_4^{2-} (chromate), or as the dimeric ion $Cr_2O_7^{2-}$ (dichromate) (e.g., Palmer and Wittbrodt, 1991; Richard and Bourg, 1991). The monomeric species impart a yellow color to the water when the [Cr(VI)] is greater than 1 mg/L. Water that contains high levels of $Cr_2O_7^{2-}$ has an orange color.

The monomeric chromate species are related through a series of acid dissociation reactions

$$H_2CrO_4^0 \rightleftarrows HCrO_4^- + H^+ \quad ; K_1$$

$$HCrO_4^- \rightleftarrows CrO_4^{2-} + H^+ \quad ; K_2$$

the pK values are -0.86 and 6.51, respectively (Allison et al., 1990). The dichromate is the result of the polymerization of the monomeric bichromate ions to form the dimer, $Cr_2O_7^{2-}$,

$$HCrO_4^- + HCrO_4^- \rightleftarrows Cr_2O_7^{2-} + H_2O \quad ; K_d$$

where pK_d is -1.54 (Allison et al., 1990). The relative concentration of each of these species depends on both the pH of the contaminated water (Fig. 1) and the total concentration of Cr(VI) (Fig. 2). Significant concentrations of $H_2CrO_4^0$ only occur under the extreme condition of pH < 1. Above pH 6.5, CrO_4^{2-} generally dominates. Below pH 6.5, $HCrO_4^-$ dominates when the Cr(VI) concentrations are low (<30 mM); but $Cr_2O_7^{2-}$ becomes significant when concentrations are greater than 1 mM, or it may even dominate when the total Cr(VI) concentrations are greater than 30 mM.

In the Cr(III)-H_2O system, Cr(III) exists predominantly as Cr^{3+} below pH 3.5. With increasing pH, hydrolysis of Cr^{3+} yields $CrOH^{2+}$, $Cr(OH)_2^+$, $Cr(OH)_3^0$, and $Cr(OH)_4^-$ (Rai, et al., 1987). At high concentrations, these ions impart a green color to the solution. Under slightly acidic to alkaline conditions, Cr(III) can precipitate as an amorphous chromium hydroxide.

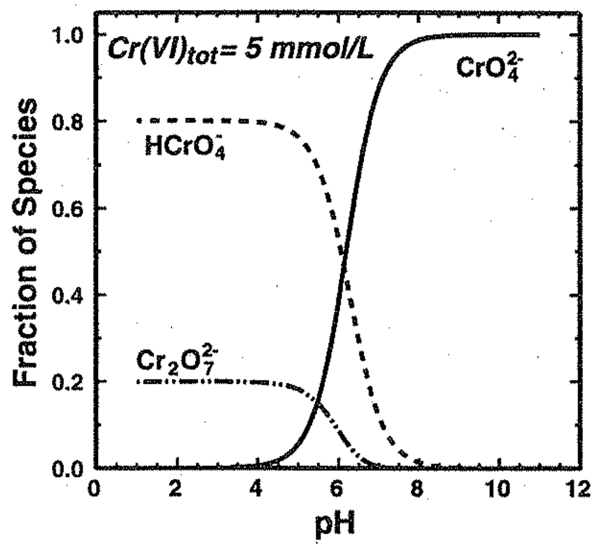

Figure 1. Distribution of Cr(VI) species as a function of pH.

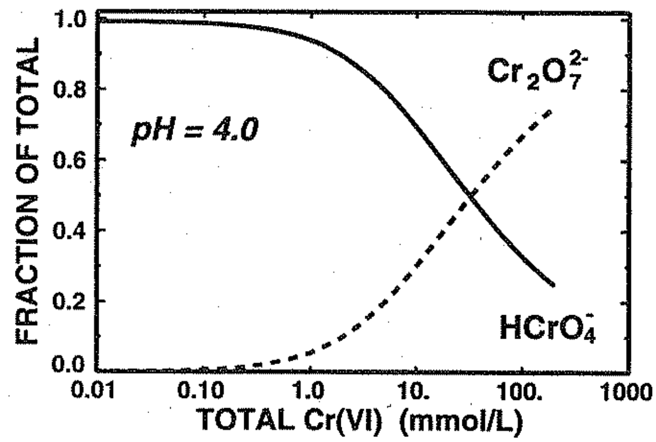

Figure 2. Fraction of bichromate ($HCrO_4^-$) and dichromate ($Cr_2O_7^{2-}$) at pH 4 as a function of the total Cr(VI) concentration.

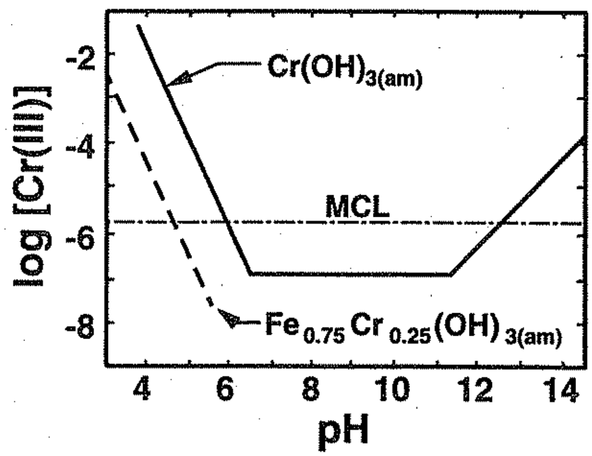

Figure 3. Cr(III) concentration in equilibrium with $Cr(OH)_{3(am)}$ and $Fe_{0.75}Cr_{0.25}(OH)_3$, based on data from Rai et al., (1987) and Sass and Rai (1987), respectively.

Amorphous $Cr(OH)_3$ can crystallize as $Cr(OH)_3 \cdot 3H_2O$ or Cr_2O_3 (eskolaite) under different conditions (Swayambunathan et al., 1989). In the presence of Fe(III), trivalent chromium can precipitate as a solid solution. If the pH within the contaminant plume is between 5 and 12, the aqueous concentration of Cr(III) should be less than 1 µmole/L (<0.05 mg/L) (Fig. 3).

There are several mineral phases that contain Cr(VI) that may be present at chromium-contaminated sites. Palmer and Wittbrodt (1990) identified $PbCrO_4$ (crocoite), $PbCrO_4 \cdot H_2O$ (iranite), and K_2CrO_4 (tarapacaite) in chromium sludge from a hardchrome plating facility. $CaCrO_4$ was found at a seepage face in a drainage ditch where there was high evaporation. Most of the contaminated ground water was at equilibrium with $BaCrO_4$ (hashemite). $BaCrO_4$ forms a complete solid solution with $BaSO_4$ (Rai et al., 1988) and can be a major impediment to the remediation of chromium-contaminated sites by pump-and-treat (Palmer and Fish, 1992; Wittbrodt and Palmer, 1992).

Reduction of Hexavalent Chromium

Cr(VI) is a strong oxidant and is reduced in the presence of electron donors. Electron donors commonly found in soils include aqueous Fe(II), ferrous iron minerals, reduced sulfur, and soil organic matter.

The reduction of Cr(VI) by ferrous iron can be written as

$$HCrO_4^- + 3Fe^{2+} + 7H^+ \rightarrow Cr^{3+} + 3Fe^{3+} + 4H_2O$$

This reaction is very fast on the time scales of interest for most environmental problems with the reaction going to completion in less than 5 minutes even in the presence of dissolved oxygen (Eary and Rai, 1988). Only when the pH is greater than 10 or when PO_4 concentrations exceed 0.1 molar does the rate of oxidation of Fe^{2+} by dissolved oxygen exceed the rate of oxidation by Cr(VI) (Eary and Rai, 1988). When the pH of the ground water is greater than 4, Cr(III) precipitates with the Fe(III) in a solid solution with the general composition $Cr_xFe_{1-x}(OH)_3$ (Sass and Rai, 1987; Amonette and Rai, 1990). If the reduction of Cr(VI) by Fe(II) is the only source of Fe(III) and Cr(III), a solid solution with the composition $Cr_{0.25}Fe_{0.75}(OH)_3$ forms via the reaction

$$HCrO_4^- + 3Fe^{2+} + 3H_2O + 5OH^- \rightarrow 4Cr_{0.25}Fe_{0.75}(OH)_3$$

(Eary and Rai, 1988; Sass and Rai, 1987). The solubility of $Cr_xFe_{1-x}(OH)_3$ decreases as the mole fraction of Fe(III) in the solid increases. Therefore, if the pH is between 5 and 12, the concentration of Cr(III) is expected to be less than 10^{-6} molar.

Numerous minerals in geologic materials contain ferrous iron that is potentially available for the reduction of hexavalent chromium. These iron-containing minerals may be silicates, oxides, or sulfides. Common ferrous iron-containing silicates include olivine; pyroxenes such as augite and hedenbergite; the amphiboles hornblende, cummingtonite, and grunerite; micas such as biotite, phlogopite, and glauconite; chlorites, and the smectite nontronite. Iron oxides such as magnetite ($Fe^{2+}Fe_2^{3+}O_4$) contain iron as a major constituent, however, hematite ($Fe_2^{3+}O_3$) can contain small amounts of (FeO). In sulfide minerals such as pyrite (FeS_2), both the ferrous iron and the sulfide are active in reducing hexavalent chromium.

Lancy (1966) suggested that pyrite could be used for treating spent cooling waters that contain Cr(VI) as a corrosion inhibitor. He stated that the reduction of Cr(VI) occurs at the pyrite surface rather than in solution. Lancy (1966) found that reduction by pyrite occurred even in slightly alkaline solutions; however, the pyrite had to be continuously abraded to remove surface coatings. Blowes and Ptacek (1992) conducted batch tests in continuously agitated reaction vessels containing a solution of 18 mg/L Cr(VI) and pyrite both in the presence and in the absence of calcite. In the experiments that used both pyrite and calcite, 50% of the Cr was removed in less than 6.5 hours. Concentrations were < 0.05 mg/L after 20 hours. Experiments conducted without the calcite attained 50% removal in 1 hour and concentrations were < 0.05 mg/L in less than 4 hours.

Cr(VI) reduction in the presence of iron oxides has been observed in several experiments. White and Hochella (1989) found that magnetite and ilmenite reduced Cr(VI) to Cr(III). The reduction of Cr(VI) in the presence of hematite (Fe_2O_3) was demonstrated by Eary and Rai (1989). They attribute the reduction to the presence of a small amount of an FeO component in the hematite. They suggest that reduction occurs in solution after the FeO component has been solubilized.

Reduction of Cr(VI) by ferrous iron-containing silicates has been reported. Eary and Rai (1989) suggest that the reduction of Cr(VI) in the presence of biotite occurs in solution rather than at the mineral surface. They observed an increase in the rate of reduction when their suspensions were spiked with Fe^{3+}. They explain their results with the mechanism proposed by White and Yee (1985) in which Fe^{3+} is reduced at the mineral surface by the reaction

$$[Fe(II),\ K^+]_{biotite} + Fe^{3+} \rightarrow [Fe(III)]_{biotite} + K^+ + Fe^{2+}$$

where the ions in the brackets denote ions within the crystal structure of biotite. To maintain charge balance, K^+ is released to solution as the iron in the crystal structure is oxidized. The Cr(VI) in solution is then reduced by the Fe^{2+}. The Fe^{3+} resulting from this reduction reaction is then adsorbed to the surface of the biotite where it is again reduced to Fe^{2+}, thus setting up a cycle that ultimately results in the reduction of more Cr(VI) than is stoichiometrically possible for the amount of iron that is in solution.

There are some key experimental difficulties in studying ground water/mineral interactions such as those just described that have some bearing on the transfer of knowledge to the field. Although the processes can in some cases be

interpreted from the data on mineral reactions, the rates themselves may be quite useless. A key difficulty in studying mineral reactions in the laboratory is that the rate of the reaction depends on how the solid phase was prepared. For example, if the samples are ground and simply washed before use, microparticles can adhere to the larger grain surfaces. These microparticles have greater specific surface area and can react at a much faster rate than the larger size particles. Such experimental artifacts were observed in weathering studies of pyroxenes (Schott et al., 1981).

Another important reductant in soils is organic matter. In fact, dichromate reduction has been used as a wet combustion method for the determination of soil organic carbon (Walkley and Black, 1934). Dichromate can react with soil organic carbon according to

$$2Cr_2O_7^{2-} + 3C^o + 16H^+ \rightarrow 4Cr^{3+} + 3CO_2 + 8H_2O$$

The Cr^{3+} may hydrolyze and precipitate as Cr-hydroxide or it may bind to the remaining soil organic carbon. Much of the soil organic carbon is present as soil humic and fulvic acids. Redox reaction with these materials has been demonstrated for several redox reactive species. Reduction of Cr(VI) by soil humic and fulvic acids has been demonstrated by Bartlett and Kimble (1976), Bloomfield and Pruden (1980), Goodgame et al. (1984), Boyko and Goodgame (1986), and Stollenwerk and Grove (1985). The rate of reduction of Cr(VI) decreases with

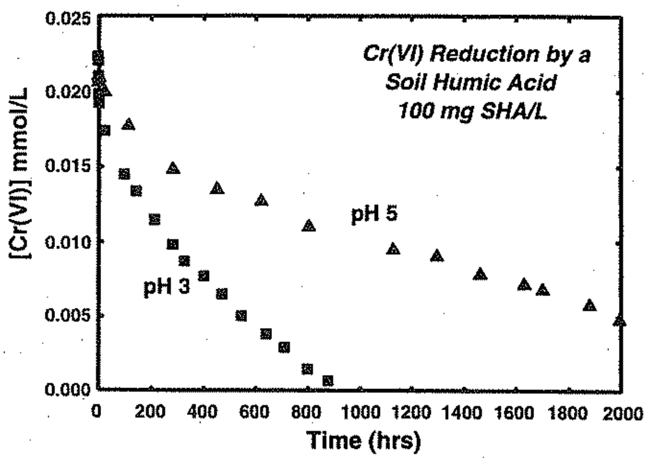

Figure 4. Reduction of Cr(VI) in a suspension of 100 mg/L soil humic acid (SHA) at pH 3 and 5 (Wittbrodt and Palmer, 1994).

increasing pH (Fig. 4), increases with the increasing initial Cr(VI) concentration, and increases as the concentration of soil humic substance increases. At neutral pH, many weeks may be required for the Cr(VI) to be completely reduced Cr(VI).

In addition to these abiotic reduction pathways, Cr(VI) can be reduced by microbes in the subsurface (Martin et al., 1994). Both aerobic and anaerobic reduction by microbes have been observed, however, the latter is more common. The mechanisms for Cr(VI) by these microbes are not well known. It may be part of a detoxification mechanism that occurs intracellularly. Alternatively, the chromate may be utilized as a terminal electron acceptor as part of the cell's metabolism. A third possibility is that reduction is an extracellular reaction with excreted waste products such as H_2S. In addition to two strains of Gram-positive bacteria, Martin et al.(1994) found a fungus in contaminated soil that was capable of reducing Cr(VI) under anaerobic conditions.

Oxidation of Cr(III)

Any evaluation of the natural attenuation of Cr(VI) must consider the potential oxidation of the Cr(III) to the toxic Cr(VI) form. In contrast to the numerous pathways for the reduction of Cr(VI), there are very few mechanisms for the oxidation of Cr(III). Only two constituents in the environment are known to oxidize Cr(III) to Cr(VI): dissolved oxygen and manganese dioxides (MnO_2) (Eary and Rai, 1987). Studies of the reaction

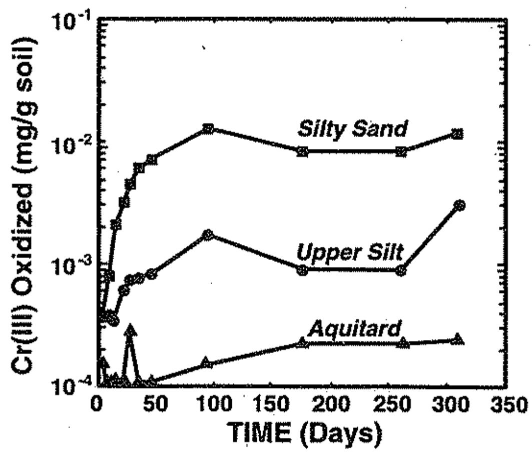

Figure 5. Cr(III) oxidized to Cr(VI) in a suspension of Willamette silt loam.

between dissolved oxygen and Cr(III) revealed very little (Schroeder and Lee, 1975) or no (Eary and Rai, 1987) oxidation of Cr(III) even for experiments conducted at pH as great as 12.5 for 24 days. Therefore, the transformation of Cr(III) by dissolved oxygen is not likely to be an important mechanism for the oxidation of Cr(III).

Oxidation of Cr(III) has been observed in several soils and sediments. The oxidation of the Cr(III) can be relatively slow requiring several months (Fig. 5). For example, Palmer and Wittbrodt (1990) monitored Cr(VI) concentrations in batch tests using three different geologic media from a site in Corvallis, OR. They observed increases in Cr(VI) concentrations over a 300-day period with Cr(VI) concentrations becoming as great as 7 mg/L in one experiment. Bartlett and Kimble (1976) did not observe oxidation of Cr(III) in their dried soils but Bartlett and James (1979, 1983) did observe oxidation in soils that were maintained in a moist state.

Bartlett and James (1979) observed a correlation between the amount of Cr(III) oxidized by soils and the amount of hydroquinone-reduced manganese in soils and suggested the oxidation of Cr(III) is the result of interaction with manganese dioxides. This hypothesis has been experimentally verified using ß-MnO_2 or pyrolusite (Eary and Rai, 1987) and δ-MnO_2 (Fendorf and Zasoski, 1992; Riser and Bailey, 1992). There is an increase in the rate and amount of Cr(III) oxidation as pH decreases, and the surface area to solution volume increases. Experimental results indicate that the oxidation follows the reaction

$$CrOH^{2+} + 1.5\ \delta\text{-}MnO_2 \rightarrow HCrO_4^- + 1.5Mn^{2+}$$

Significant oxidation of Cr(III) was observed in less than 1 hour (Fendorf and Zasoski, 1992) and continued for more than 600 hours (Eary and Rai, 1987). Eary and Rai (1987) developed an empirical rate law for the oxidation of Cr(III) by ß-MnO_2; however, the zero point charge for this phase is quite different than birnessite which is more commonly found in soils. Therefore, this rate law may not be applicable to manganese dioxides in soils.

Perspective on the Natural Attenuation of Cr(VI)

If hexavalent chromium can be reduced and immobilized in the subsurface as a result of interaction with naturally existing reductants, then expensive remedial measures may not be required at certain sites. In principle, the natural attenuation of Cr(VI) in the subsurface is feasible. There are several natural reductants that can transform Cr(VI) to Cr(III). If the pH of the contaminant plume is between about 5 and 12, Cr(III) precipitates as $Cr(OH)_3$ or as part of a solid solution with Fe(III), thereby keeping Cr(III) concentrations below 1 µmole/L (0.05 mg/L). Whether or not natural attenuation at a particular site is a viable option depends on the characteristics of both the aquifer and the contaminant plume under investigation.

The potential reductants of Cr(VI) include aqueous species, adsorbed ions, mineral constituents, and organic matter. When a contaminant plume containing hexavalent chromium enters the subsurface, it displaces the ground water containing the dissolved reductants. There is little mixing of the waters containing the reducing agents and the Cr(VI)-contaminant plume. What mixing does occur will be driven by molecular diffusion at the front of the plume or from the edges of the plume and diffusion from lower permeability lenses containing relatively immobile water. Thus, aqueous reductants such as Fe^{2+} are not going to be important in reducing hexavalent chromium. Mixing of reductants and Cr(VI) in the plume are going to occur primarily through the interactions of the plume with the immobile soil matrix. Such interactions include desorption of reductants such as Fe^{2+} from mineral surfaces, direct and indirect surface redox reactions between Cr(VI) and the mineral surfaces, and reduction by soil organic matter. Thus, it is the soil matrix that is most important with regard to redox transformations of chromium in the subsurface. This argument is further supported by studies that clearly demonstrate that ground water contributes less than 1% of the oxidation capacities (equivalents of Cr oxidized per gram of soil) and reduction capacities (equivalents of Cr reduced per gram of soil) of aquifer systems while the soil matrix contributes the remaining fraction (Barcelona and Holm, 1991). Thus, any discussion of redox transformations of chromium in the subsurface must focus on the soil matrix.

Three key factors must be addressed in considering the potential use of natural attenuation of Cr(VI) in the subsurface. Firstly, the reduction capacity of the aquifer, R_c, must be great enough to reduce all of the Cr(VI) that passes through it. If x_c is the distance from the source to the point of compliance (Fig. 6), the total mass of Cr(VI) from the source, M_0, must be less than the total mass of Cr(VI), M_r, that can be reduced by the aquifer material between the source and x_c:

$$M_o \leq M_r = x_c A \rho_b R_c \quad (1)$$

where A is the cross-sectional area of the plume normal to the direction of ground water flow and ρ_b is the dry bulk density of the aquifer. As x_c increases, the mass of Cr(VI) that can be reduced increases. A key difficulty in applying this criterion is in providing a reasonable estimate of M_0. In the absence of other reactions such as adsorption or precipitation, the minimum rate of movement of the Cr(VI) front through the aquifer, v_{min}, computed by assuming the reductant reacts instantaneously with the Cr(VI), is

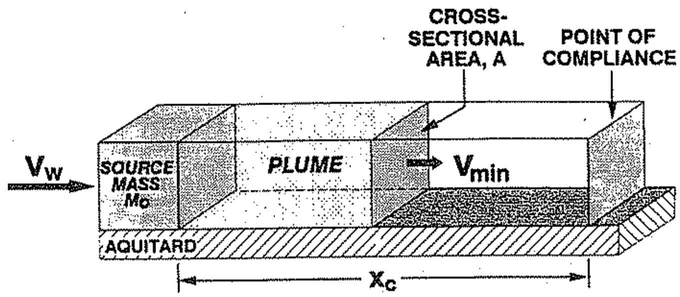

Figure 6. Cr-plume moving from the source area to the point of compliance. The initial Cr(VI) concentration in the source area is M_0, V_w is the ground water velocity, v_{min} is the velocity of the Cr(VI) front assuming instantaneous reduction of the Cr(VI), and x_c is the distance from the source area to the point of compliance.

$$v_{min} = \frac{v_w}{1 + \frac{\rho_b}{\theta_v}\frac{R_c}{C_o}} \quad (2)$$

where ρ_b and θ_v are the dry bulk volumetric water content of the porous medium, v_w is the velocity of the ground water, and C_0 is the concentration of the chromium in the contaminant plume.

The second key factor in the application of natural attenuation of Cr(VI) is the rate of reduction relative to the rate of advective transport in the subsurface. The time for the reduction reaction to decrease the concentration from its initial concentration, C_0, to some target concentration, C_s, such as a drinking water standard, should be less than the residence time of the contaminated water in the portion of the aquifer between the source of the Cr(VI) and the point of compliance. For example, if the rate of reduction of Cr(VI) follows a first-order rate equation

$$\frac{dC}{dt} = -kC \tag{3}$$

the time for the concentration of Cr(VI) to decrease from C_0 to C_s must be less than the residence time of the contaminated parcel of water within the aquifer:

$$\frac{\ln(C_o / C_s)}{k} \leq \frac{x_c}{v_w} \tag{4}$$

If natural attenuation is to be a viable option, this criterion must be met. Difficulties in utilizing this criterion arise in applying the appropriate rate equation and obtaining the pertinent rate coefficients.

A third factor concerning the natural attenuation of Cr(VI) is the possible oxidation of Cr(III) to the more toxic hexavalent form. While contamination is actively entering the subsurface, conditions may favor the reduction of Cr(VI) to Cr(III). After the source of the active contamination is removed, however, chemical parameters within the aquifer, particularly pH, may be altered. Under the new conditions, oxidation of Cr(III) may be favored. Thus, soil containing Cr(III) formed during the active contamination phase may become a source of Cr(VI).

Both oxidation and reduction of chromium are occurring simultaneously within the subsurface as part of a geochemical cycle. As the Cr(III) is oxidized to Cr(VI) by manganese dioxides in the soil, Cr(VI) can be reduced to Cr(III) by some reductant such as soil organic carbon or pyrite. The rate of change in [Cr(VI)] (d[Cr(VI)]/dt) is the sum of the rate of reduction of Cr(VI), R_{red}, and the rate of oxidation of Cr(III), R_{ox}:

$$\frac{d[Cr(VI)]}{dt} = \left[\frac{[Cr(VI)]}{dt}\right]_{red} + \left[\frac{[Cr(VI)]}{dt}\right]_{ox} = R_{red} + R_{ox} \tag{5}$$

If a soil initially contains both Cr(VI) and Cr(III), then [Cr(VI)] increases when $R_{red} + R_{ox} > 0$ and decreases when $R_{red} + R_{ox} < 0$. Ultimately, the [Cr(VI)] will reach a steady state; i.e., d[Cr(VI)]/dt = 0. At this time, the rate of loss of Cr(VI) via reduction is balanced by the rate of production by the oxidation of Cr(III):

$$-R_{red} = R_{ox} \tag{6}$$

Wittbrodt and Palmer (1994) suggest that the reduction of Cr(VI) by soil fulvic acid can be represented by

$$R_{red} = -k_{red} X_e^{-1} [HCrO_4^-][SHS][H^+]^p \tag{7}$$

where [SHS] is the concentration of soil humic substance and X_e denotes the equivalent fraction of the humic substance that has been oxidized. Fendorf and Zasoski (1992) suggest that $CrOH^{2+}$ is the reactive species in the oxidation of Cr(III) by MnO_2. For illustrative purposes, assume that the oxidation reaction follows a rate equation of the form

$$R_{ox} = k_{ox} [CrOH^{2+}] [A / V]^m [H^+]^n \tag{8}$$

where (A/V) denotes the surface area of the MnO_2 per unit volume of solution. If we further assume that the solution is equilibrated with $Cr(OH)_{3(am)}$, then

$$R_{ox} = k_{ox} \left(K / K_w^2\right)(A / V)^m [H^+]^{n+2} \tag{9}$$

where K_w is the dissociation constant for H_2O and K is the equilibrium constant for the reaction

$$Cr(OH)_{3(am)} \rightleftarrows Cr(OH)^{2+} + 2(OH^-)$$

Equating R_{ox} with $-R_{red}$ and rearranging the terms yields

$$\left[HCrO_4^-\right] = \frac{k_{ox}}{k_{red}} \frac{K}{K_w^2} X_e \frac{(A / V)^m}{[SHS]} [H^+]^{n+2-p} \tag{10}$$

Although some of the specific points of rate equations presented here are debatable, equation 10 does illustrate aspects of natural attenuation in soils that contain both a reductant and MnO_2. The key point is that as long as the supply of reductant and MnO_2 have not been significantly depleted, $[HCrO_4^-]$ does not converge to zero with increasing residence time within the aquifer as one would expect for a first-order reaction that only considers reduction of Cr(VI). Rather, $[HCrO_4^-]$ converges to some steady-state concentration that is > 0 that may or may not be above the MCL. This steady-state concentration increases with increasing k_{ox}/k_{red}, and $(A/V)^m/[SHS]$ and it varies with pH. Thus, in principle, if the rate equations are correct and all of the parameters are known, one could calculate the steady-state Cr(VI) concentration and determine if natural attenuation could achieve compliance goals. Studies of the kinetics of these coupled processes need to be done to verify the general forms of the rate equations and to determine the appropriate rate coefficients.

Determining the Potential for Natural Attenuation

If "natural attenuation" is to be considered an alternative to expensive remediation efforts, additional characterization is required to demonstrate that the expectations are likely to be met. There is no single test that can tell us if natural

attenuation of Cr(VI) will occur at a particular site. Several tests are briefly described which have been utilized to address key factors affecting Cr(VI) transport in the subsurface and describe how the results can be utilized in determining the potential for the natural attenuation of Cr(VI) in the subsurface.

Ideally, it must be demonstrated that 1) there are natural reductants present within the aquifer, 2) the amount of Cr(VI) and other reactive constituents does not exceed the capacity of the aquifer to reduce them, 3) the rate of Cr(VI) reduction is greater than the rate of transport of the aqueous Cr(VI) from the site, 4) the Cr(III) remains immobile, and 5) there is no net oxidation of Cr(III) to Cr(VI). Some of these criteria are relatively simple while others require additional tests and interpretation. Additional tests that will be required include tests of the oxidizing and reducing capacities of the aquifer.

Mass of Cr(VI) at the Source

It must be demonstrated that the amount of Cr(VI) in the aquifer does not exceed the capacity of the soil for reducing this chromium. Therefore, an important first step in evaluating the potential for natural attenuation is to determine the mass of Cr(VI) in the soil. Chromium exists in the subsurface either in solution or in association with the solid phase. Cr(VI) in solution can be determined by the diphenylcarbazide (DPC) method (APHA, 1989). Aqueous samples are most often obtained from monitoring wells. Alternatively, water separates from the soil matrix either by centrifugation or by squeezing. The pH of these waters should be measured to determine if it is within the proper range (5.5 to 12) to insure the Cr(III) concentrations are less than 1 μM (0.05 mg/L).

Cr(VI) associated with the soil matrix may be adsorbed to mineral surfaces (particularly iron oxides) or precipitated as chromate minerals. There is no precise method for determining each of these fractions of Cr(VI); nonetheless, determinations have been made using sequential extractions. An initial water extraction serves to remove remaining pore water and dissolve highly soluble chromium minerals present in the soil or that may have precipitated as the result of evaporation during sample handling and storage. This water extraction also removes some adsorbed ions.

Following the water extraction, a phosphate extraction is used as a measure of the "exchangeable" chromate in the soil (Bartlett and James, 1988). The test is conducted by adding phosphate to the soil and equilibrating for 24 hours. The water is then separated from the slurry and Cr(VI) is measured by the DPC method (Bartlett and Kimble, 1976; Bartlett and James, 1988). The increase in the chromate concentration is the amount of "exchangeable" chromate. Amacher and Baker (1982) found optimal extraction using 0.01 M monobasic potassium phosphate (KH_2PO_4). James and Bartlett (1983b) used a solution of 0.005 M KH_2PO_4 and 0.05 M K_2HPO_4 to yield a pH of 7.2. James and Bartlett (1983b) stated that doing the extraction at pH 7.2 is preferred because there is less likelihood of chromate reduction than at lower pH. However, decreasing the pH of the soil slurry can result in dissolution of $BaCrO_4$ from the soil. Moreover, if the pH of the soil water was initially low, then increasing the pH to 7.2 can cause precipitation of $BaCrO_4$, thereby complicating the interpretation of the results. When the soil water is not equilibrated with $BaCrO_4$, the phosphate extraction method of James and Bartlett (1983b) primarily measures the amount of adsorbed Cr(VI) in the soil. The phosphate removes chromate by both directly competing for the adsorption sites in the soil and indirectly (in some cases) by increasing the pH.

$BaCrO_4$ is a likely chromate mineral phase that can be a source of Cr(VI) in contaminated aquifers. There is no direct test for $BaCrO_4$ in soils, however, when the ground water is equilibrated with this phase and the source of the Ba^{2+} is entirely from the clays in the natural soil, the maximum amount of $BaCrO_4$ in the aquifer is equal to the ammonium acetate exchangeable Ba^{2+} (Thomas, 1982) in background soils. For example, Palmer and Wittbrodt (1990) found that the amount of exchangeable Ba^{2+} was useful in estimating the number of pore volumes required to flush Cr(VI) from soil columns.

At many sites, the total Cr(VI) associated with the soil matrix is the sum of the $BaCrO_4$ and the PO_4-extractable Cr(VI). This sum, S, is often reported in units of mass per gram of soil. The total concentration of Cr(VI) in the soil, $Cr(VI)_{tot}$ is the sum of the aqueous Cr(VI) and the matrix associated Cr(VI), S, which can be reported in common units of mass per unit volume of water by

$$Cr(VI)_{tot} = [Cr(VI)] + \frac{1000\,\rho_b}{\theta_v} S \qquad (11)$$

where the dry bulk density of the soil, ρ_b, is in g-cm^{-3}. The total mass of Cr(VI) in the site soils can then be estimated by integrating the concentrations over the volume of contaminated soil.

Mass of Cr(III) in the Subsurface

If all of the chromium that entered the soil was Cr(VI), then demonstrating the presence of Cr(III) in the soil would prove that reduction is occurring. The mass of Cr(III) in the soil can provide a measure of the amount of reduction that has occurred. Although proof of chromate reduction is necessary, it is not sufficient for demonstrating that natural attenuation will adequately protect the environment.

The total amount of Cr(III) present in the soil is the sum of the mass in solution as well as mass associated with the solid phase. Total chromium in solution can be determined by atomic absorption spectrophotometry (AAS) or inductively coupled plasma spectroscopy (ICP). When total chromium is statistically greater than Cr(VI), Cr(III) can be simply determined by difference.

The amount of Cr(III) associated with the soil matrix has ostensibly been determined using several techniques. An

ammonium oxalate (0.1 M) extraction serves to remove amorphous hydroxides of Cr, Fe, and Al (Ku et al., 1978; Borggaard, 1988). Bartlett (1991) suggests that a K_2H-citrate extraction provides a measure of the Cr(III) that is potentially removable by low molecular weight organic molecules. A dithionate-citrate-bicarbonate (DCB) extraction is conducted by adding 0.3 M sodium citrate and 0.1 M sodium bicarbonate to the soil sample and heating to 80°C for 20 minutes. One gram of sodium dithionate is then added and the soil slurry is stirred for another 15 minutes. The DCB extraction removes the crystalline forms of the Cr-, Fe-, and Al-oxyhydroxides (Ku et al., 1978; Borggaard, 1988). The dithionate reduces crystalline iron (goethite) in the soil and Cr, Fe, and Al are complexed by the citrate. In addition to the Cr(III) oxyhydroxides, the DCB method also extracts sparingly soluble Cr(VI) mineral phases such as $BaCrO_4$, thereby complicating interpretation of the results. Bartlett (1991) uses 40 mL per gram of soil of 0.7 M NaOCl solution (undiluted laundry bleach) at pH 9.5 to extract chromium. The slurry is placed in a boiling water bath for 20 minutes before the liquid is separated and Cr is determined by AAS or ICP. This method is useful in determining total chromium in the soil because it readily oxidizes and removes Cr(III) that is not removed by other methods.

Identification of Potential Reductants

The presence of Cr(III) in the soil may be indicative of active reduction in the soil, or it may be the result of the neutralization of acidic waters containing Cr(III) with subsequent precipitation of chromium hydroxides. Therefore, identification of specific reductants within the aquifer is warranted. The identification of some potential reductants at a site can be fairly simple in some cases. For example, pyrite (FeS_2), a common constituent in many geological materials, is readily identifiable by its visual characteristics. Other mineral phases capable of reducing Cr(VI) can be identified using classical petrographic techniques or powder x-ray diffraction. Scanning electron microscopy (SEM) can be utilized to identify crystallite morphology. SEMs equipped with energy dispersive x-ray spectroscopy can also provide information about the elemental composition of these crystallites. Electron diffraction patterns obtained from transmission electron microscopes provide crystallographic information. Such electron microscopy methods can, however, be relatively expensive. A fairly simple and inexpensive test for organic carbon can provide a measure of the amount of carbon available for reduction of Cr(VI). Knowledge of the specific reductant within the aquifer is useful in determining the time scale for the reduction of Cr(VI) based on studies that are reported in the literature. Soils containing iron sulfides or organic matter are more likely to reduce Cr(VI) on the time scales of interest than soils containing ferrous iron silicates.

Reduction Capacity of the Aquifer

Adequate protection of the environment by natural attenuation of Cr(VI) requires that the soil possess a large enough reducing capacity to reduce all the hexavalent chromium in the source area. Several measures for predicting reduction of Cr(VI) in soil are presented by Bartlett and James (1988) and Bartlett (1991). A measure of the maximum amount of Cr(VI) that can be reduced per unit mass of aquifer, the **"total Cr(VI) reducing capacity,"** can be obtained using the classical Walkley-Black method for determining soil organic carbon (Bartlett and James, 1988). In this method, 2 to 3 grams of soil are reacted with a mixture of 1N $K_2Cr_2O_7$ in 1N H_2SO_4 for 30 minutes (Walkley and Black, 1934; Nelson and Sommers, 1982; Bartlett and James, 1988). The Cr(VI) concentration is measured using the diphenylcarbazide (DPC) method (APHA, 1989) and the decrease in the mass of Cr(VI) in the reaction vessel per gram of soil used in the test is the reduction capacity. Although this method of determining soil organic carbon has its limitations (e.g., Nelson and Sommers, 1982), it is a direct measure of how much Cr(VI) can be reduced by a soil at extreme acid concentrations. Variations on this method use heat or a combination of heat and pressure (Nelson and Sommers, 1982). Barcelona and Holm (1991) used a modified closed-tube chemical oxygen demand procedure (U.S. EPA, 1979) to determine reduction capacities.

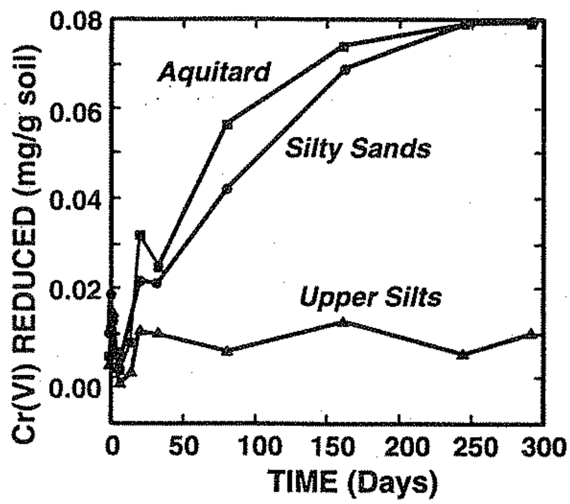

Figure 7. Cr(VI) reduced to Cr(III) in Willamette silt loam.

The extreme conditions of pH and temperature used in the total Cr(VI) reducing capacity test may yield a greater reducing capacity than would be available under most environmental conditions. The **"available reducing capacity"** test of Bartlett and James (1988) determined the reduction capacity by reacting about 4 to 5 grams of moist soil in a solution of 10 mM H_3PO_4 and $K_2Cr_2O_7$ for 18 hours. The H_3PO_4 is added to buffer the pH and to compete with the Cr(VI) for the adsorption sites. When KH_2PO_4 is used Bartlett and James referred to it as the **"reducing intensity."** These tests are designed to determine the reducing capacity at pH values more likely to be encountered in the field. However, in long-term reduction tests at near neutral pH, Palmer and Wittbrodt (unpublished data) observed reduction occurring after 250 days (Fig. 7). Such long-term reduction tests are not practical at most waste sites.

Oxidation Capacity

A potential limitation to the use of natural attenuation of Cr(VI) in soil is the oxidation of the Cr(III) to Cr(VI) by MnO_2. If the oxidizing capacity of the soil is greater than the reduction capacity, then as the chromium is cycled in the soil it could exhaust the soil reductant and be oxidized and ultimately mobilized in the soil. It is important, therefore, to determine the capacity of the aquifer to oxidize Cr(III).

Bartlett and James (1988) suggest a relatively simple test for the amount of Cr(III) that can be oxidized by a soil. The method involves adding 2.5 grams of soil to a solution containing 25 ml of 1 mM $CrCl_3$. After shaking for 15 minutes, a solution of $KH_2PO_4 \cdot K_2HPO_4$ is added to the reaction vessel, the slurry centrifuged or filtered, and the Cr(VI) measured using the DPC method. Moist soils should be used in these tests. Drying the soils alters the surfaces of the manganese dioxides making them less reactive (Bartlett and James, 1979).

Barcelona and Holm (1991) used a solution of chromous (Cr(II)) ion to measure the oxidation capacity of soils. They added about 1 g of soil to cuvettes containing the Cr(II) solution. The work was performed in a glove box to prevent oxygen from reacting with the Cr(II). The cuvettes were sealed, shaken, and allowed to react for 2 hours. The samples were centrifuged and the Cr(II) measured spectrophotometrically. The loss of Cr(II) is then used as a measure of the oxidation capacity of the soils.

Each of these methods has some problems. Palmer and Wittbrodt (unpublished data) conducted oxidation tests similar to the Bartlett and James (1988) method except that the concentration of Cr(VI) was monitored over nearly a year. Cr(VI) concentrations in these tests continued to increase up to 100 days and may have been continuing after 300 days. For one soil, the short-term oxidation test of Bartlett and James underestimated the amount of oxidation obtained in the long-term tests by more than an order of magnitude. It is not clear in the Barcelona and Holm method whether the Cr(II) is being oxidized to Cr(III) or Cr(VI) or some combination of the two. If both products are forming, the results are more difficult to interpret.

If the only mechanism for the oxidation of Cr(III) in soils is oxidation by manganese oxides, then using extraction methods specifically designed for this purpose may be a good way of determining the oxidation capacity of the soils. One very simple extraction technique (Chao, 1972; Gambrell and Patrick, 1982) utilizes 0.1 M hydroxylamine hydrochloride ($NH_2OH \cdot HCl$) in 0.1 M HNO_3. About 0.5 g of soil is added to 25 mL $NH_2OH \cdot HCl$ of the solution and shaken for 30 minutes and the Mn concentration is measured. The number of moles of Cr(III) that can be oxidized is then computed by dividing the number of moles of Mn^{2+} per gram of soil obtained in the extraction by 1.5. The hydroxylamine hydrochloride test is fast, easy, and specifically targets the phase that promotes the oxidation of Cr(III).

Rates of Oxidation and Reduction

Key factors in the suitability of natural attenuation as an option for chromium-contaminated soils are the rates of oxidation and reduction of chromium. This information is the most difficult to obtain. Scientists are only now learning about the form of the applicable rate equations and the appropriate rate coefficients that may apply. Such kinetic studies are an area where research has lagged behind the practical need for the information. While rates can be obtained from the technical literature, one must be careful to use rates of reduction for materials that are most likely controlling the Cr(VI) reduction in the site soil. In addition, because the rates depend on the concentration (surface area per liter of solution) of the reductant and pH, it is important to obtain rate coefficients that were acquired under conditions similar to those at the site. Many rate studies have considered only a limited set of conditions such as a single pH value or one reductant concentration. Consequently, the reported rate coefficients are apparent values that are strictly valid only under the conditions of the experiment. Thus, the experimental factors must be taken into account before the rate coefficients can be applied to field problems.

When MnO_2 is present, Cr(III) may be oxidized back to Cr(VI) and the net rate of reduction will be less than that obtained from experiments that only utilize reductants. Further, many rate experiments are conducted in stirred reactors that can abrade reactive surfaces. In soils, the rate of reaction may become surface limited as adsorbed ions and precipitates cover the reactive surfaces.

One method of obtaining the net rate of reduction is through tests on uncontaminated soils obtained from the site. These soils should be similar to those through which the contaminant plume will be migrating. Cr(VI) can be added to the soil slurry and the Cr(VI) concentrations monitored over time. The reaction vessels must exclude light to prevent photoreduction reactions and the slurry must have the same pH as the contaminant plume. A key limitation to such experiments is that they require several months to a year to complete.

Estimating Reduction from Monitoring Well Data

In principle, Cr(VI) reduction can be estimated from the decrease in the mass of Cr(VI) in the aquifer (e.g., Henderson, 1994). The key difficulty in such an approach is to estimate the mass of Cr(VI) using the aqueous concentrations. The total mass of Cr(VI) in the aquifer is the sum of the mass that is in solution, the mass that is adsorbed to the aquifer matrix, and the mass that is precipitated within the aquifer. The mass of Cr(VI) in solution is obtained by integrating the Cr(VI) concentrations over the volume of the contaminated aquifer

$$M_{aq} = \theta_v CV \tag{12}$$

where V is the volume of aquifer containing a plume with a Cr(VI) concentration of C.

The mass of Cr(VI) adsorbed to the soil matrix, M_{ads}, can be computed from the adsorption isotherm. For example, if Cr(VI) follows a Langmuir isotherm, then over a volume of aquifer, V, with constant aqueous Cr(VI) concentration, C, M_{ads} can be computed as

$$M_{ads} = \rho_b \left[\frac{S_{max} K_{ads} C}{1 + K_{ads} C} \right] V(1 - \theta_v) \qquad (13)$$

where K_{ads} is the Langmuir adsorption constant, S_{max} is the maximum amount of contaminant that can be adsorbed to the soil.

There is no unique amount of Cr(VI) precipitate for a given hexavalent chromium concentration. Therefore, it is impossible to estimate mass of this fraction of Cr(VI) in the subsurface using only the measured concentrations in monitoring wells. Thus, natural attenuation of Cr(VI) from mass balances using monitoring well data can only be used when it can be reasonably demonstrated the Cr(VI) precipitates cannot form within the aquifer.

Even when it is demonstrated that the formation of precipitates within the aquifer is unlikely, there are inherent problems with any monitoring system that can create uncertainties in the estimated mass of Cr(VI) during a sampling round. In the three-dimensional flow field, the highest concentrations from one sampling period may migrate between the discrete monitoring points of the next sampling round. The undetected mass is not included in the total mass estimates in the second sampling round and may be mistakenly interpreted as mass loss due to Cr(VI) reduction.

Summary

Under certain conditions, toxic Cr(VI) can be reduced to the less toxic Cr(III) in soils and precipitated as an insoluble hydroxide phase. The possibility of relying on such "natural attenuation" of Cr(VI) is attractive because of the great expense of remediating chromium-contaminated sites. Before such an option is adopted, however, it should be demonstrated that natural attenuation is likely to occur under the specific conditions at the site being investigated.

If natural attenuation is to be considered a viable option for chromium-contaminated sites, then ideally, it must be demonstrated that 1) there are natural reductants present within the aquifer, 2) the amount of Cr(VI) and other reactive constituents does not exceed the capacity of the aquifer to reduce them, 3) the time scale required to achieve the reduction of Cr(VI) to the target concentration is less than the time scale for the transport of the aqueous Cr(VI) from source area to the point of compliance, 4) the Cr(III) will remain immobile, and 5) there is no net oxidation of Cr(III) to Cr(VI). The most difficult information to obtain are the time scales for the reduction and oxidation of chromium in the soil.

Demonstrating Cr(VI) reduction in aquifer by mass balances that rely primarily on the aqueous concentrations from monitoring well networks are valid only if it is demonstrated that Cr(VI) precipitates are not forming in the aquifer. The monitoring network must be sufficiently dense that estimates of Cr(VI) are accurate.

Several soil tests are described that are useful in determining the mass of Cr(VI) and Cr(III) in the source areas and the reduction and oxidation capacities of the aquifer materials. Some simple conceptual models are presented whereby this information, combined with knowledge of the residence time of the chromium between the source and the point of compliance, can be used to determine the feasibility of natural attenuation of Cr(VI). The major limitation to this approach is the lack of information about the rate of oxidation and reduction of chromium under conditions likely to be encountered by plumes emanating from chromium sources. Without better information about these rate processes under a wider range of conditions with respect to pH, the use of the natural attenuation option for contaminated soils will continue to be a highly debated issue.

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Transport and Transformation of Hexavalent Chromium Through Soils and into Ground Water

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ABSTRACT: A detailed characterization of the underlying and adjacent soils of a chrome-plating shop was performed to provide information on the extent of soil and aquifer contamination at the site and on the potential for off-site migration and environmental impact. Intact, moist cores were obtained from more than 40 different locations, resulting in more than 200 discrete samples for total metal analysis, selective extraction tests, and adsorption-reduction experiments, to assess the chemical speciation and distribution of chromium on the contaminated soils and its leaching potential. Surface analytical techniques were also used to determine chemical speciation and to further elucidate mineral fractions responsible for retention of the chromium on the soils and sediments. Adsorption and reduction capacities of the saturated aquifer sediments were variable and low, while the unsaturated soils' reduction capacities were much greater and were correlated with depth (decreasing capacity with increasing depth). The soils' adsorption and reduction capacities were eventually overwhelmed, however, and permitted the passage of Cr(VI) into the underlying ground water. Adsorption capacity differences were primarily related to clay content and pH, and less so to the presence of amorphous iron oxide coatings on matrix minerals as operationally defined by the selective extraction methods used in the study. Reduction of Cr(VI) to Cr(III) and subsequent precipitation as (Fe, Cr)$(OH)_3$ is proposed as the primary attenuation mechanism in the unsaturated soils immediately beneath the shop, based on extraction and surface analyses results.

KEY WORDS: chromate, amorphous iron oxide, groundwater.

I. INTRODUCTION

Knowledge of the chemical speciation and distribution of chromium at hazardous waste sites is essential for adequate site characterization and risk assessment. Contaminant speciation, whether dissolved or in association with solid surfaces,

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will affect the toxicity and mobility of most contaminants in subsurface systems. Chromium contamination of subsurface soils and ground water supplies has increasingly been discovered over the past decade from a variety of industrial sources or uses (DOE, 1992; Sims, 1986; USEPA, 1988). Some of these include the manufacture of pigments, printing inks, photographic film, corrosion inhibitors, fungicides, ferrous and nonferrous alloys, and in the leather tanning and electroplating industries. Hard-chrome plating, in particular, has been used extensively in the manufacturing of components for both commercial and military aircraft.

Chromium is present in subsurface systems and natural waters in primarily the +3 and +6 oxidation states (Richard and Bourg, 1991). In the more reduced +3 state, chromium is cationic and exists primarily as $CrOH^{2+}$ and $Cr(OH)_3^0$, but also complexes with other inorganic and organic ligands (Richard and Bourg, 1991; Moore and Ramamoorthy, 1984; James and Bartlett, 1983). Hexavalent chromium (+6) exists primarily as CrO_4^{2+} and $HCrO_4^-$ in natural systems (Richard and Bourg, 1991). The latter species are much more toxic, more soluble, and more mobile in environmental systems than the +3 forms (USEPA, 1978; Palmer and Wittbrodt, 1991; Ajmal *et al.*, 1984; Benoit, 1976; Mathur *et al.*, 1977; Ross *et al.*, 1981) — hence, the importance of accurate characterization of its speciation at hazardous waste sites. Chromium reduction from +6 to +3 occurs where the presence of another redox couple provides the required three electrons. In natural subsurface systems, the important redox couples in this regard are H_2O/O_2 (aq), Mn^{2+}/Mn^{4+}, NO_2/NO_3, Fe^{2+}/Fe^{3+}, S^{2-}/SO_4^{2-}, and CH_4/CO_2 (Richard and Bourg, 1991). Mineral phases capable of providing ferrous iron through dissolution or through surface-mediated reactions include biotite, magnetite, iron sulfides, chlorite, and nontronite (Eary and Rai, 1989; White and Yee, 1985; Komadel *et al.*, 1990; White, 1990). Soil organic matter may also reduce hexavalent chromium (Bartlett and Kimble, 1976; Bloomfield and Pruden, 1980; James and Bartlett, 1983). Several studies have indicated that chromium reduction is favored under acidic conditions, and whether in the presence or absence of significant quantities of soil organic matter (Carey *et al.*, 1977; Bloomfield and Pruden, 1980; Grove and Ellis, 1980; Stollenwerk and Grove, 1985; Davis *et al.*, 1991). Chromium oxidation appears to be largely governed by manganese oxides in subsurface systems that occur mainly as surface coatings, crack deposits, or finely disseminated grains (Bartlett and James, 1979; Richard and Bourg, 1991). The proposed reaction involves the sequential adsorption of trivalent chromium onto MnO_2 surface sites followed by oxidation by surface Mn^{4+} and subsequent release or desorption of hexavalent chromium (Bartlett and James, 1979; Rai *et al.*, 1986; Eary and Rai, 1987; Manceau and Charlet, 1992). Eary and Rai (1987) found that oxygen does not oxidize trivalent chromium to any significant extent, and that the rate of Cr^{3+} oxidation by β-MnO_2 decreases with increasing pH and decreasing surface area to solution volume.

Adsorption reactions can play a significant role in the attenuation of chrome in natural subsurface systems. Trivalent chromium is strongly and specifically adsorbed, and as with most cationic species, its adsorption increases with increasing pH (Korte *et al.*, 1976; Bartlett and Kimble, 1976; Griffin *et al.*, 1977; Rai *et al.*, 1984). For hexavalent chromium, adsorption is also strongly pH dependent, but increases with decreasing pH (Griffin *et al.*, 1977, Bartlett and James, 1979; Davis and Leckie, 1980; Rai *et al.*, 1984, 1986, 1988; Zachara *et al.*, 1988, 1989). Zachara *et al.* (1988, 1989) have also shown decreased chromate adsorption with increasing dissolved inorganic carbon and sulfate. James and Bartlett (1983) showed decreased adsorption of chromate with increased phosphate and sulfate. Increases in ionic strength have also shown decreased chromate adsorption (Davis and Leckie, 1980; Rai *et al.*, 1984, 1986). The observed adsorption competition by phosphate, carbonate, and sulfate, and decreased adsorption with increasing ionic strength, suggest an outer-sphere surface complexation reaction with various mineral surfaces. Interestingly, James and Bartlett (1983), also found a preference for chromate adsorption over reduction on some soils.

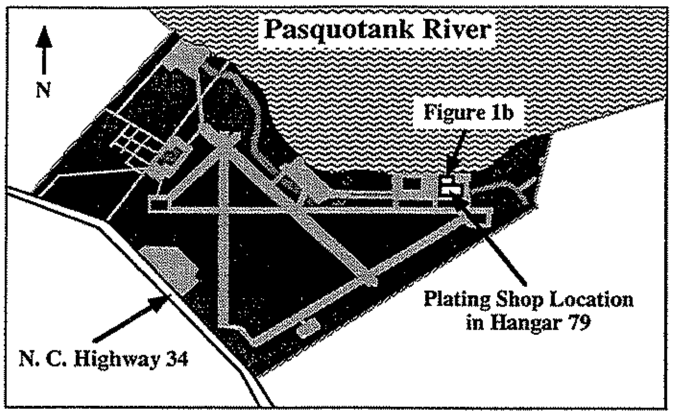
The solubility of trivalent chromium is quite low in the pH range of 6 to 12 and is governed primarily by $Cr(OH)_3$ formation (Rai *et al.*, 1987). Chromium hydroxide solid solutions may also form, in particular an amorphous $Cr_xFe_{1-x}(OH)_3$ phase (Sass and Rai, 1987; Amonette and Rai, 1990). The latter solubility decreases with a decreasing fraction of Cr^{3+}. Important mineral phases governing the solubility of hexavalent chromium include $PbCrO_4$ (crocoite), $PbCrO_4 \cdot H_2O$ (iranite), K_2CrO_4 (tarapacaite), and $BaCrO_4$ (hashemite). Rai *et al.* (1988) have shown the latter phase to form a continuous solid solution with $BaSO_4$ (barite). The formation of these phases ($Ba(Cr_xS_{1-x})O_4$) at hazardous waste sites can result in aqueous equilibrium chromate concentrations well in excess of maximum contaminant levels for drinking water (Palmer *et al.*, 1990).

Due to the rather ubiquitous occurrence of chrome-plating sites and attendant environmental pollution, research was initiated to study this generic-type site from the standpoint of site characterization and remediation. A cooperative project between the U.S. Coast Guard and the Robert S. Kerr Environmental Research Laboratory, U.S. Environmental Protection Agency, was initiated in 1990 to initially determine the speciation and distribution of chromium on unsaturated contaminated soils and underlying and adjacent saturated aquifer sediments. In particular, the objectives of the research were to:

1. Perform selective extractions to infer metal speciation on the solid phase.
2. Perform laboratory experiments to determine the adsorption and reduction capacities (i.e., specific reactivity) of the soils and saturated aquifer sediments.
3. Use surface analytical techniques to further elucidate chromium speciation and mineral associations.

II. STUDY SITE

The field site is located at the U.S. Coast Guard Support Center near Elizabeth City, NC, about 100 km south of Norfolk, VA, and 60 km inland from the Outer Banks of North Carolina. The base is located on the southern bank of the Pasquotank River, about 5 km southeast of Elizabeth City. A chrome-plating shop, located within hangar 79 on the base, had been in use for more than 30 years, and had discharged acidic chromium wastes through a hole in the concrete floor into the soils immediately below the shop's foundation, creating a chromium plume in the ground water beneath and to the north of the shop, with an aqueous chromate concentration in excess of 10 mg/l (Figure 1). The site geology consists of typical



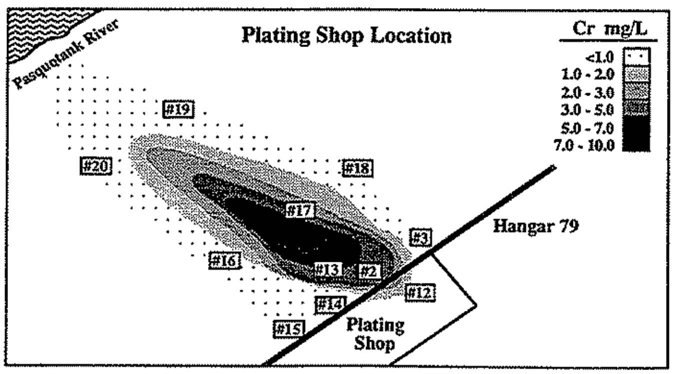


FIGURE 1. (a) Plating shop location in hangar 79, east end of base, about 60 m south of the Pasquotank River; (b) chromium ground-water plume beneath the pavement (ground-water table at about 2 m below ground surface) outside the plating shop and flowing toward the river.

Atlantic coastal plain sediments characterized by complex and variable sequences of surficial sands, silts, and clays. In the vicinity of the plating shop, the uppermost soils are silty clay, overlying a thin sandy clay layer at about 2 m, which overlay sands and silty fine sands, with occasional pockets and lenses of silt and clay. In some locations, a dense gray clay layer substitutes for the sandy clay at 2 m. Fine to medium sands dominate from 4 to 20 m. A dense gray clay unit persists at a depth of 20 m. This depth is slightly variable and dips gently from north to south. Figures 2a and b are representative geologic and soil profiles for the site.

III. MATERIALS AND METHODS

A. Sample Collection

Soil samples were collected using a Giddings Model GSRP-ST, trailer-mounted soil coring and sampling machine. Hollow-stem augers (7-cm i.d.) and soil sampling tubes (5.1-cm i.d., 1.2-m long) with plastic liners were used for coring and sampling. Recovered intact cores, in the plastic liners, were then cut into various-length sections, depending upon the soil recovery efficiency and sampling intervals. Recovery efficiencies ranged from 70 to 86% (0.8 to 1.0 m). The cores were subdivided into 15-cm subsections, and the top 2-cm from each 15-cm section was cut off for XRF analysis and subsequent ICP analysis for total metals. All 13- and 2-cm subsections were then capped and taped, labeled, and stored in coolers with ice for transport to the laboratory. Upon return to the laboratory, the samples were stored in the dark at 4°C. Samples were recovered from 48 different locations within and immediately outside the plating shop and at various depths, totalling 236 samples for total metal analysis. Several of the samples from within the shop area were combined into a total of eight composites based on texture or clay content and total chromium. Composites were labeled as follows:

Table 1 lists some physical and chemical parameters for these soil samples. These were air-dried and sieved through a 2-mm sieve. Only the <2-mm fraction was used in the extractions and adsorption-reduction experiments.

B. Selective Extractions

Selective extractions, specific for exchangeable chromium (VI), were performed using sodium solutions with different exchangeable anionic compositions. The desorption or extracting solutions used were

1. 0.005 *M* NaH_2PO_4, 25°C, shaken 0.5 to 24 h
2. 0.005 *M* sodium dodecyl sulfate, 25°C, shaken 24 h
3. 0.007 *M* NaCl, 25°C, shaken 24 h

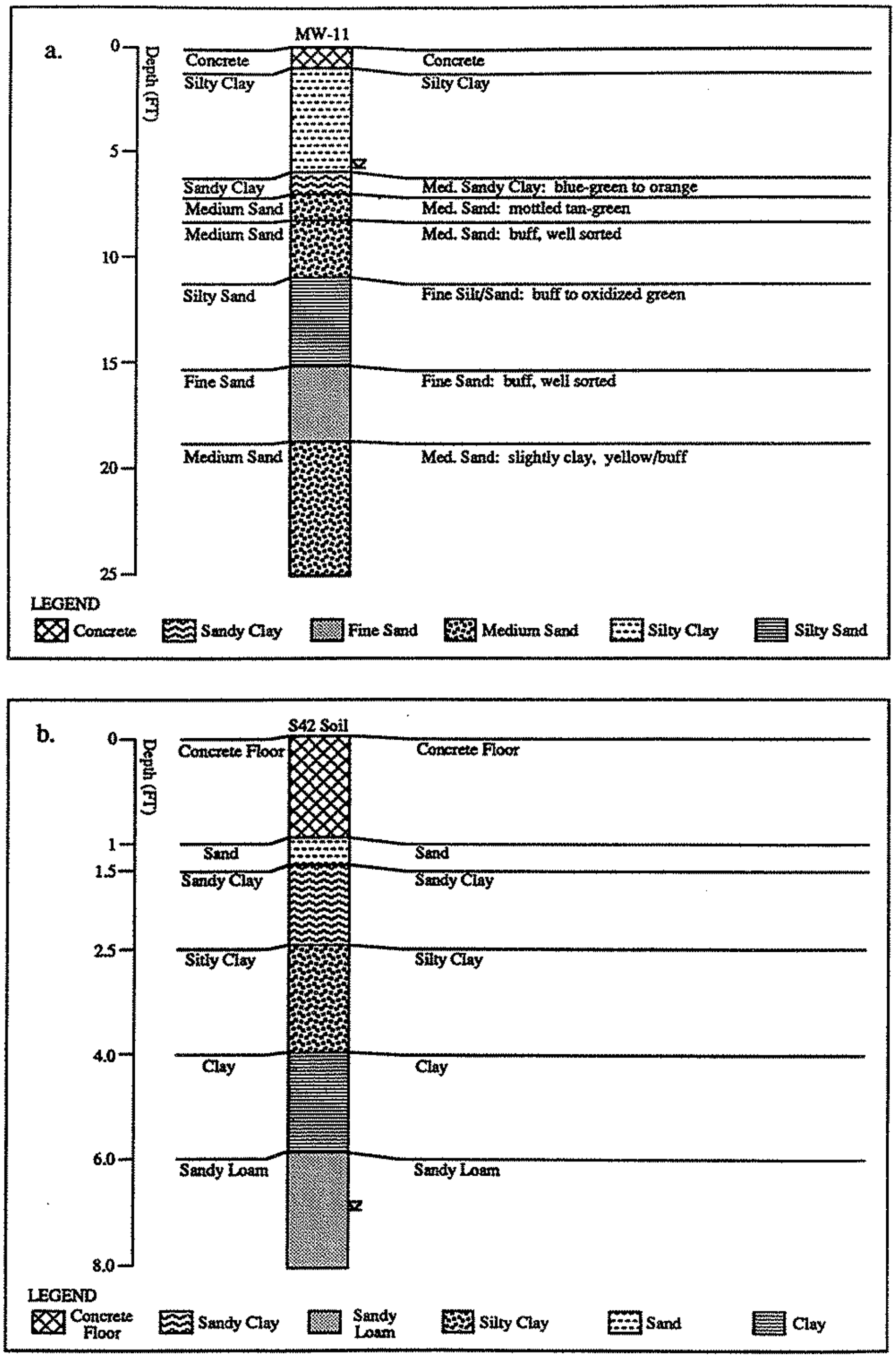


FIGURE 2. Representative (a) geologic and (b) soil profiles for the plating shop site near Elizabeth City, NC.

TABLE 1
Data Summary for Composite Soil Samples and Selected Individual Soil Samples Used in the Study (mg/kg)

Sample[a]	pH	TOC[b]	Cr[c]	Fe[c]	Fe[d]	Fe[e]	Fe[f]	PO4[g]	Texture	Depth[b]
L1	—	0.07	38	8,450	—	—	1,344	38.4	SL	6.5
L2	6.2	0.06	223	17,800	—	—	1,680	49.8	SCL	6.5
M1	6.1	0.13	32	11,700	261	899	1,096	0	SiCL	3.0
M2	6.5	0.15	449	13,100	357	991	1,253	44.5	SC	5.5
M3	6.2	0.29	1,600	11,200	145	1,026	2,110	6.9	SiCL	3.7
H1	6.3	0.09	54	20,800	551	425	1,672	0	C	4.0
H2	6.0	0.09	522	23,300	291	343	1,544	47.9	C	4.0
H3	6.6	0.22	979	12,300	399	1,432	1,840	10.2	SiCL	4.0
S46	6.0	0.27	2,260	5,160	257	416	2,330	1.3	S	1.5
S49	6.1	0.98	4,150	5,700	382	422	2,308	0.8	S	2.5
S51	5.9	0.70	9,420	6,000	100	223	2,388	2.1	LS	2.8
11OC[h]	7.1	0.10	32	12,200	705	1,606	2,141	22.7	SL	7.5
MW13[h]	7.1	0.06	43	16,400	375	1,041	—	9.3	SL	7.5

[a] L, sandy texture; M, medium texture; H, clayey texture; 1, low Cr Content (20–60 mg/kg); 2, medium Cr content (200–600 mg/kg); 3, high Cr content (900–1600 mg/kg).
[b] TOC in percent; depth in feet.
[c] Total metal (SW846 Method 3050).
[d] Hydroxylamine hydrochloride in HCL, 50°C, extracted.
[e] DCB extracted.
[f] Hydroxylamine hydrochloride in acetic acid, 96°C, extracted.
[g] Percent phosphate extracted.
[h] Aquifer sediment samples.

All samples were adjusted to a representative soil pH of 7.0. Desorptions were performed using 4.000 g soil and 20 ml of solution in 50-ml polycarbonate centrifuge tubes, with 24-h equilibrations. The samples were then centrifuged for 60 min at 2800 × g. Of the total 20-ml volume, 16 ml were carefully pipetted off and filtered through 0.2-μm Nuclepore filters to minimize inclusion of colloidal particles. Samples for total Cr analysis were acidified with 200 μl of ultrapure HNO_3. Preliminary experiments indicated 93 to 105% recovery of added chromate to pristine (chromate-free) sandy sediments from the site following 24-h equilibrations with 0.005 *M* NaH_2PO_4. Comparisons were also made with shorter equilibration times (30 min to 2 h) and using a greater phosphate concentration (0.01 *M* NaH_2PO_4), but these results showed no significant differences in chromate recovery nor any indications of mineral dissolution with these soils and sediments. Recovered total chromium was analyzed using a Jarrell-Ash Model 975 inductively coupled plasma (ICP), while Cr^{3+} was analyzed using a dionex exchange column in-line with the ICP. Cr (VI) was verified as the difference between the two analyses by a colorimetric method using diphenylcarbazide reagent as a complexing agent (Skougstad *et al.*, 1979). In some cases, multiple (3) desorptions were

performed on the same samples by repeated replacement of the pipetted sample volume (16 ml) following centrifugation with the same desorption solution. Corrections were made for residual solution concentrations for successive desorption steps.

The procedure of Chao and Zhou (1983), using hydroxylamine hydrochloride, heated at 50°C and shaken for 30 min, was used for determination of the amorphous iron oxide-associated chromium fraction. For an assessment of the more crystalline oxide-associated fraction, the method of Mehra and Jackson (1960) was used (a dithionite-citrate bicarbonate (DCB) system, samples heated to 80°C, and the extraction repeated three to five times). The crystalline iron oxide extraction procedure of Tessier *et al.* (1979) was also used for comparison with the DCB extraction method. The former uses 0.04 *M* NH_2OH-HCl in 25% v/v CH_3COOH at higher temperature (96°C) and for a longer equilibration time (6 h). Comparisons were also made with fresh (preserved moist, 4°C) and air-dried samples, but no significant differences were observed in the extraction results.

Concentrated nitric acid digestions were performed for "total" metal analyses. These were made using 0.5 to 1.0 g of sample and Teflon® beakers. The procedure used was EPA Method 3050A (SW846, 3rd ed.). These results formed the basis for determinations of percent extractable chromium (or iron) for the other extraction results described above.

C. Mineral Matrix and Surface Analytical Techniques

The following equipment was used to characterize site mineralogy, determine the presence of discrete chromium precipitated phases, and identify mineral assemblages associated with adsorbed or precipitated chromium:

- X-Ray diffraction (XRD); Scintag
- Scanning electron microscopy with energy dispersive X-ray (SEM-EDS); Cambridge 360 SEM with Link Analytical QX-2000 energy dispersive X-ray
- Time of flight secondary ion mass spectrometry (SIMS); TFS Surface Analyzer (Ga^+ microfocused ion beam)
- X-ray photoelectron spectroscopy (XPS) or electron spectroscopy for chemical analysis (ESCA); Perkin Elmer 5500 ESCA system

XRD was used primarily to determine the primary and secondary minerals present in the soils at the site. SEM-EDS was also used for site minerals characterization, but was primarily used to semiquantitatively assess the chromium loading on the different minerals and determine, at least qualitatively, the effects of different extractions on particle morphology and mineral surface coatings.

Random samples of extracted soil fractions were selected and prepared for these analyses using both gold and carbon coating. SIMS is a rapid, easily used technique that permits qualitative identification of all surface elements and structural elucidation of molecular compounds on the surface of solids. Detection sensitivity is in parts per million with a minimum of sample volume. Depth composition of about two atomic monolayers (about 0.6 nm) is normally obtained, although depth profiling can also be performed. XPS is concerned with the measurement of core-electron binding energies and provides information on the oxidation state of surface-associated elements. In XPS, the ionizing source is an X-ray photon that ejects an inner-core electron. The energy of the ejected electron is characteristic of the atom involved and its chemical environment. Only photoelectrons from the outermost layers of a surface escape and are measured. Hence, only the outer approximately 2 nm is probed with this technique.

D. Chromium Adsorption and Reduction on Uncontaminated Soils

Adsorption and reduction of hexavalent chromium was assessed using laboratory batch techniques on uncontaminated soils and sediments. The batch adsorption-reduction procedures were similar to the desorption procedures described above. For the adsorption experiments, soil composites M1 and H1, and aquifer sediments 11OC and MW13, were used (Table 1). These soils and sediments had no detectable, readily leachable chromium using the desorption solutions referenced above. Four grams of soil were mixed with 20 ml of 0.007 *M* NaCl, 0.007 *M* $NaSO_4$, or 0.005 *M* NaH_2PO_4. Solutions were spiked with Cr (VI) using a Rainen EDP-Plus electronic motorized pipette, providing initial chromium concentrations of 1.9, 9.6, 19.2, 96.0 192.0, and 960 μM Cr (VI). The pH was adjusted, when necessary, to the representative site pH range of 6.5 to 7.0 and was checked before and after equilibration. Equilibration time was 24 h, based upon preliminary kinetic experiments (rotary shaker, 1000 rpm). Following equilibration, the samples were centrifuged (60 min at 2560 × g; Beckman). The concentrate was then filtered through 0.2-μm Nuclepore membrane filters and acidified with ultrapure HNO_3 to pH <2 for analysis by ICP. Initially, samples were also analyzed for Cr^{3+} using a dionex exchange column in-line with the ICP. This was later discontinued except for selected check samples, as very little (less than 1% and less than 0.38 μM) dissolved Cr^{3+} was ever present in solution. Cr^{6+} was also analyzed directly by a colorimetric method using diphenylcarbazide reagent as a complexing agent (Skougstad *et al.*, 1979) and compared with total Cr as measured by the ICP. The uncontaminated site ground-water composition was most closely simulated with 0.007 *M* NaCl. A 0.01 *M* NaH_2PO_4 solution was used for desorption and to estimate the reduction of Cr (VI). As discussed above, the phosphate was very effective in removing the adsorbed chromate, and that fraction not removed was operationally defined as reduced. The extracted solutions were analyzed similarly to the equili-

brated sorption solutions. Air-dried soils (<2.0 mm) were used for most experiments.

IV. RESULTS AND DISCUSSION

A. Selective Extractions

A comparison of the results using single-step extracting solutions specific for the exchangeable or easily extractable Cr (VI) is shown in Figures 3a, b, and c. The order of extraction efficiency was always: phosphate > dodecyl sulfate > chloride. Although not shown, the dodecyl sulfate desorptions provided the same efficiency

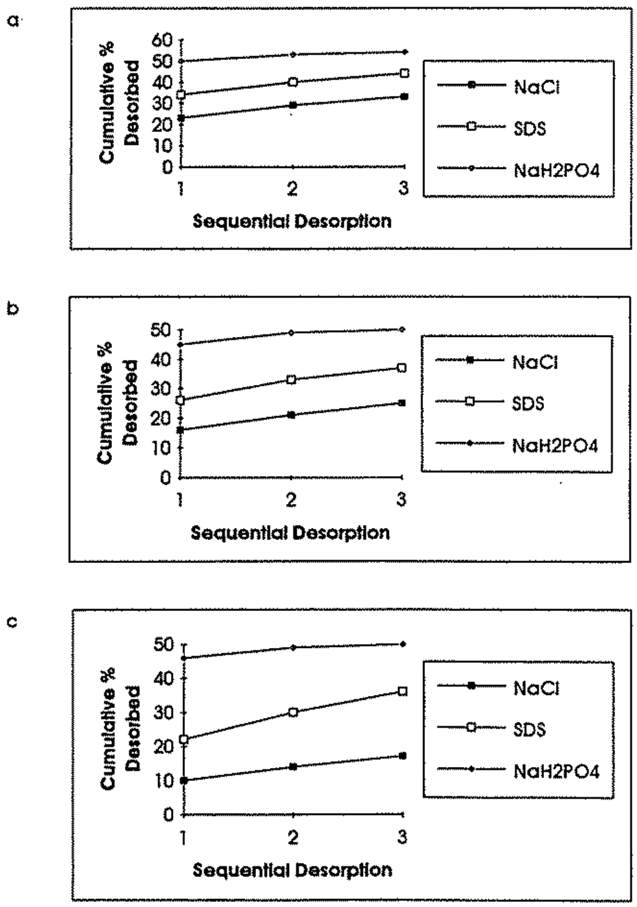


FIGURE 3. Comparison of Cr(VI) desorption or extraction results for various solutions (0.007 *M* NaCl, 0.005 *M* sodium dodecyl sulfate, and 0.005 *M* NaH_2PO_4) using soil samples (a) H2, (b) M2, and (c) L2.

as inorganic sulfate. Figure 4 shows the results of the single-step extractions for selected soils with phosphate, hydroxylamine hydrochloride, and dithionite-citrate-bicarbonate. The depth of the soil samples increases moving from right to left in the figure, or the percentage of extractable chromium with phosphate increases with increased depth. Table 1 is a partial compilation of physical and chemical parameters for these and other soils as well as aquifer sediment samples. The only obvious trends observed were with total chromium, total organic carbon (TOC), and depth. It is particularly noteworthy that no obvious trends are apparent with respect to extractable iron. This was pursued further with a continuous core sampling at a location in the shop adjacent to the contaminant source. Trends were observed with depth, pH, TOC, and percent phosphate extractable chromium (Table 2).

A bivariate and multivariate statistical analysis using simple and multiple linear regression (CSS Statistica) was performed on the 13 different soils or composite samples listed in Table 1. The strongest bivariate correlations with respect to chromium were total Cr and TOC (0.9555), percent phosphate-extractable Cr and total Fe (0.8132), and percent phosphate-extractable Cr and increased depth (0.7408). In the multivariate analyses, percent phosphate-extractable Cr was positively correlated with increased depth and total iron, and negatively correlated with clay, TOC, and total Cr (0.9945). These relationships are also reflected for the continuous (with depth) core sample S42 (Table 2).

The lack of correlation or trends with respect to the various forms of extractable iron and the strong correlation with TOC may be significant. It would appear that

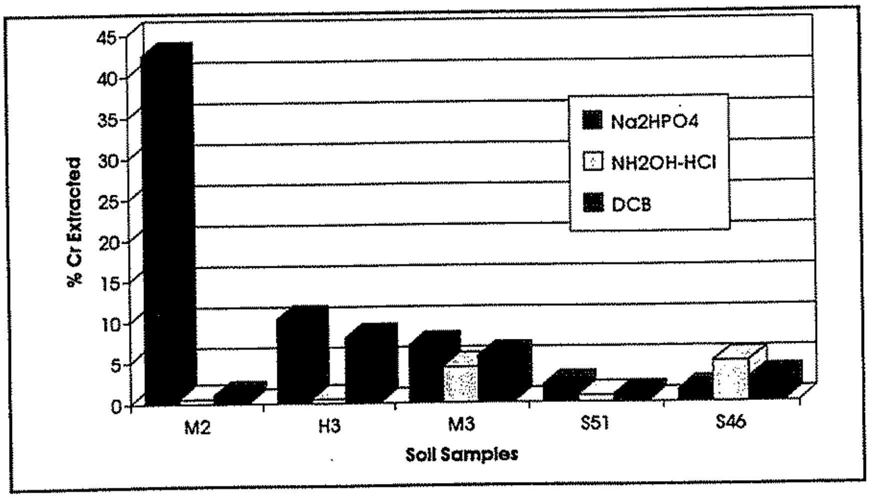


FIGURE 4. Comparison of total chromium extraction results using sodium dihydrogen phosphate, hydroxylamine hydrochloride (50°C), and dithionite citrate bicarbonate on selected soil samples.

TABLE 2
Continuous Vertical Core (Sample S42) Near Point of Contaminant Release Below Shop

Depth (ft)	TOC	pH	Cr-total	PO_4-extr. Cr	%PO_4-extr. Cr
4	0.108	5.95	924	178	19
5	0.087	5.97	700	136	19
6	0.089	5.98	574	150	26
7	0.049	6.26	196	69	35

Note: TOC in percent, Cr in milligrams per kilogram, PO_4-extr. Cr = phosphate extractable Cr, in milligrams per kilogram.

the most likely source of reductant for the disposed chromium wastes was oxidizable organic matter, and iron, with the latter present as amorphous mineral coatings and crystalline phases. Iron is abundant in both the soils and aquifer sediments and readily available for the formation of an insoluble $Cr_xFe_{1-x}(OH)_3$ phase. TOC typically decreases with depth in soils — thus the trend of increasing percent Cr (VI) with increased depth. Likewise, clay content increases with depth, and kaolinite has been shown to adsorb Cr (VI) (Zachara *et al.*, 1988). As the reduction capacity of the soils was exhausted from the continuing chromic acid wastes, transformation to the immobile Cr (III) form decreased, and more of the Cr (VI) remained oxidized and migrated or reacted with soil surfaces in this form. The low pH of the wastes would also favor the reduction process; however, as the contaminant front moved deeper within the soils, the pH-buffering capacity of the soils would mitigate this effect, thus contributing to less chromium reduction with increased depth. The slight trend of increasing pH with increased depth would also result in less adsorption of the chromate anion (Zachara *et al.*, 1988, 1989). Total and extractable iron for the aquifer sediments are not significantly different than for the surface soils; however, pH is higher and TOC is considerably lower (Table 1). Finally, the kinetics of chromium reduction in conjunction with the hydraulic characteristics of the waste stream may be significant in explaining the Cr (III)/Cr (VI) distributions. A large volume input with large head pressures may have simply permitted the chromium to bypass the redox-active surface zone during individual waste disposal events.

The hydroxylamine hydrochloride extraction values steadily increase as total chromium increases, and the residual or most resistant fraction (total metal digest) is greatest (55 to 85%) in the low total-chromium samples and only constitutes about 20 to 25% of the other fractions (Table 1). While there were no clear trends based on soil texture, generally the highest total chromium samples were in the finer-textured soils. It is interesting that the intermediate chromium content soils (L2, M2, and H2) have the greatest leachable percentages. Differences are so great that even in an absolute sense, these soils leach more total chromium than the more

contaminated composites (M3, H3). This trend was also evident with the most contaminated individual soil samples recovered (4000 to 9500 mg/kg), where the easily extractable fractions were less than 5% (Table 1).

B. XRD and Surface Analytical Results

XRD results showed the principal soil and sediment matrix mineral to be quartz. Other primary minerals were albite, plagioclase, orthoclase, and muscovite. Kaolinite was the most abundant clay mineral in addition to a 14-Å clay mineral. The latter could be chlorite or a montmorillonite. No specific chromium phases were identified with XRD, but a number of smaller peaks were present in repeated samples. These peaks might be used for fingerprinting a chrome phase, if a pure phase sample were available for analysis.

SEM-EDS analyses were reflective of the major minerals identified by XRD. In addition, large chromium and iron peaks were ubiquitous in the highly contaminated samples (>500 mg/kg). Figure 5 is a representative EDS spectra. The most likely phase is a mixed $Cr_xFe_{1-x}(OH)_3$ phase. This spectra was generally associated with aggregates rather than single crystals, and the major mineral substrate was usually a feldspar, although sometimes a silica grain.

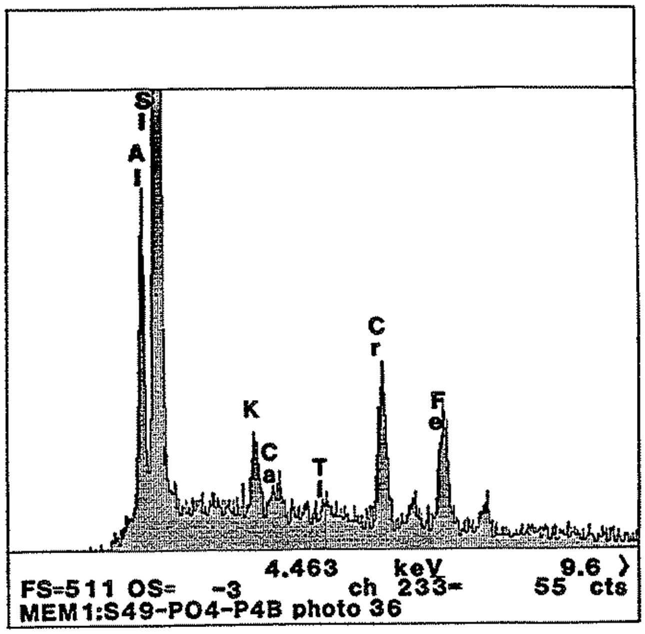


FIGURE 5. Representative energy dispersive X-ray spectra for soil sample S49, showing chromium and iron peaks on K-feldspar grain.

Clay coatings were generally present and responsible for the aggregate formation. SEM-EDS analyses were also used to qualitatively assess the impacts of various extractions on particle surface morphology and attempt a semi-quantitative analysis of chromium removal efficiency. The latter was generally unsuccessful. There were no discernable differences observed in EDS spectra before or after extraction of soil samples with phosphate, DCB, or the low-temperature (50°C) hydroxylamine hydrochloride extracts. Only in the high-temperature (96°C) hydroxylamine hydrochloride in acetic acid were there significant decreases in the chromium and iron peaks (Figure 6). This seemed to indicate that the chromium-iron hydroxide coatings on the particle surfaces were relatively thick.

SIMS analyses were limited to the same highly contaminated shop soils (>500 mg/kg) and confirmed that the chromium was primarily present as a mixed $Cr_xFe_{1-x}(OH)_3$ phase, which typically occurred on the surfaces of feldspar and silica grains (Figure 7). The spectra for chromium and iron were always nearly identical. The sampling ion (gallium) beam can be used to sputter away the surface of the sample to discriminate between matrix and surface-coating elemental composition. Depth profiling of a 200-μm-square area of two samples indicated a thickness of the chromium-iron hydroxide layer in excess of 10 nm

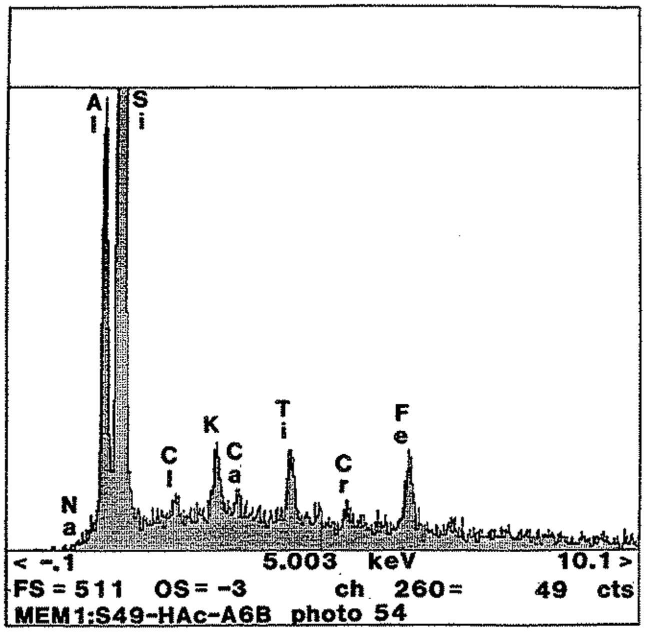


FIGURE 6. Energy dispersive X-ray spectra for soil sample S49, showing diminished chromium and iron peaks and shift in Cr-Fe ratio peak intensity on K-feldspar grain following extraction with high-temperature (96°C) hydroxylamine hydrochloride in acetic acid.

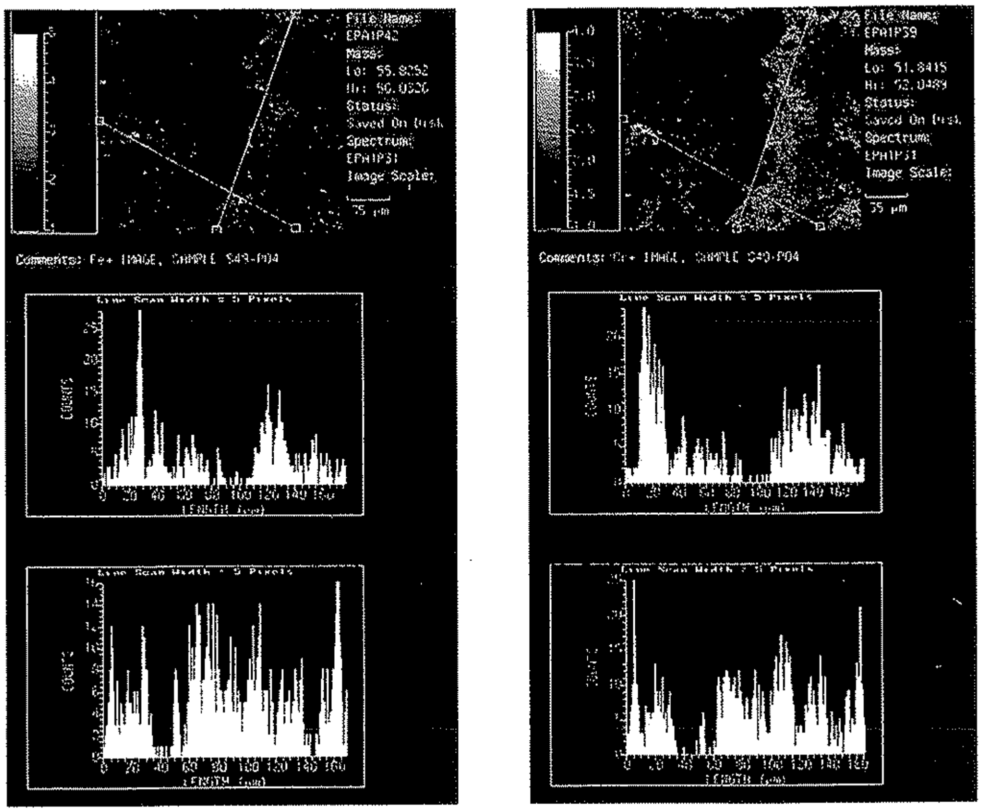


FIGURE 7. Secondary ion mass spectrometer (SIMS) spectra for soil sample S49, showing intensity of Fe and Cr occurrence on the surface of a feldspar grain. Similarity of intensity distribution and spectral images indicates coincidence of Cr with Fe on grain surface.

(Figure 8). In all samples, depth profiling of the sample surface removed chromium and iron and enhanced the images for underlying Si, Al, Na, Ca, and K. There was considerably more chromium than iron present in the shallow, highly contaminated samples. This trend was reversed in the deeper, less contaminated samples.

XPS analyses confirmed that virtually all the chromium in the highly contaminated samples was present as Cr (III). There was no strong evidence for the presence of Cr (VI), although there were indications in some samples. The detection sensitivity for this method was somewhat lower than for the other methods. Iron was found to be primarily in the oxidized form, and the ratio of Cr to Fe was between 0.2 and 5.0. The lower ratios were observed in the deeper (less contaminated) samples, consistent with the Cr-to-Fe ratios observed in the SIMS spectra. Surface-bound carbon concentrations were quite high in the surface or highly contaminated samples, but significantly lower in the deeper, less contaminated

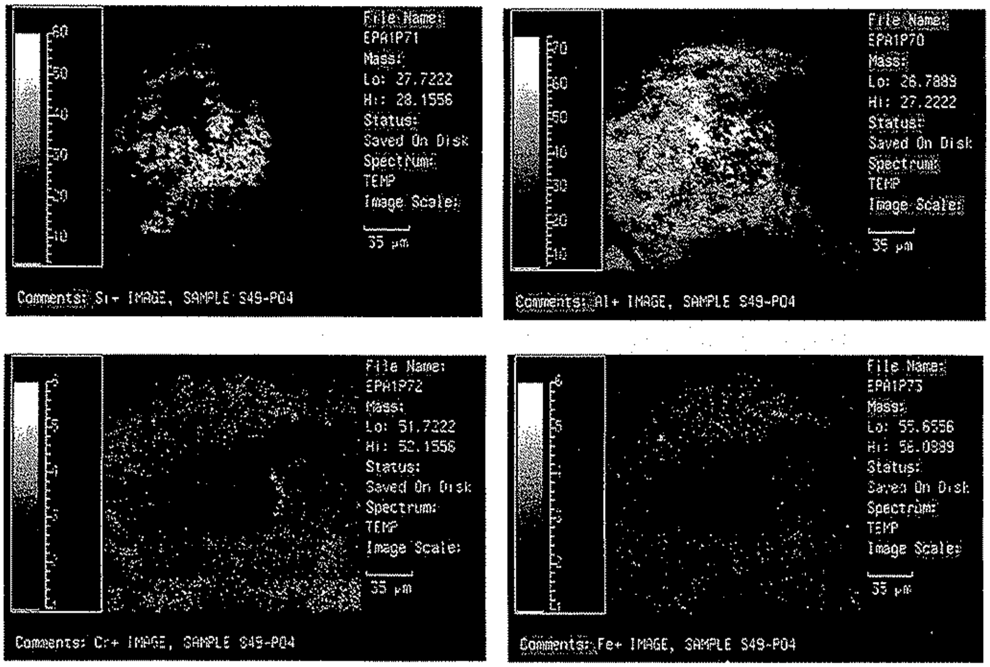


FIGURE 8. Intensity distribution patterns for Si, Al, Cr, and Fe on soil sample S49. The surface was sputtered away in a progressively deeper rectangular pattern, revealing four distinct layers. Increasing ion beam penetration toward the center of the images. For Si and Al, the intensity increased with depth, while the opposite was true for Cr and Fe. Total penetrated depth slightly exceeded 10 nm.

samples, consistent with overall TOC trends and speculation concerning the role of organic carbon in chromium reduction in the surface soil layers. Nitrogen was also detected in all samples in an organic-bound form.

C. Chromium Adsorption and Reduction

Relatively uncontaminated surface soils (M1, H1) and aquifer sediments (11OC, MW13) were used in batch experiments to determine the overall surface reactivity of the materials in an attempt to understand chromium transport through the soils and into the ground water at the site. Figure 9 shows the sorption isotherms for soil samples M1 and H1 and aquifer sediment samples 11OC and MW13. Overall sorption reactivity was on the order H1 > M1 >11OC > MW13. All of the data were also fitted using the Langmuir isotherm defined by the relation

$$S = \frac{kbC_f}{1 + kC_f} \tag{1}$$

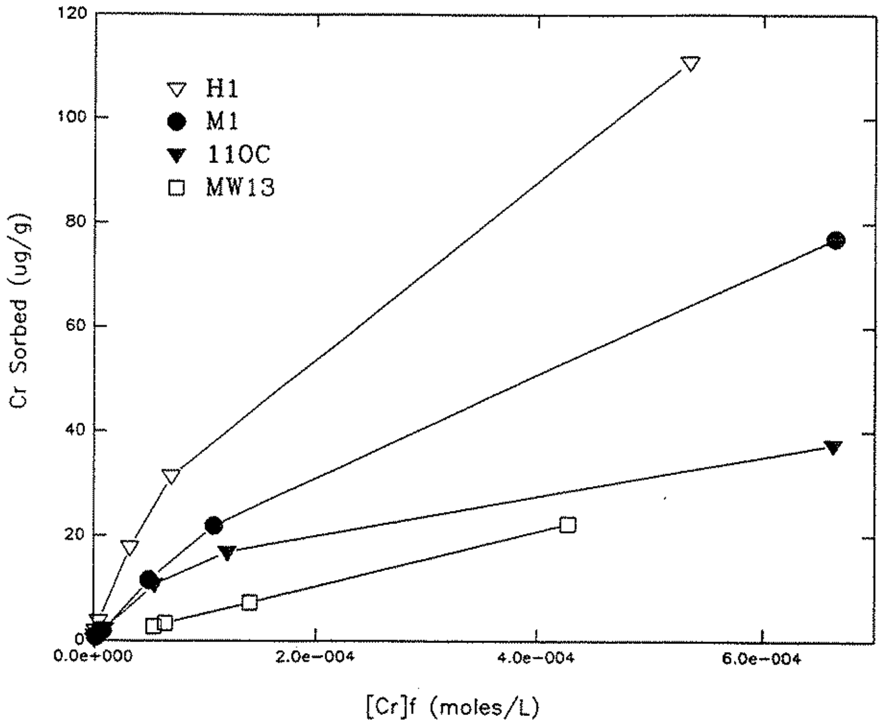


FIGURE 9. Sorption isotherms for soil (H1, M1) and aquifer sediment (11OC, MW13) samples showing the large differences in reactivity for the soil vs. sediment samples.

where k is the Langmuir solid-surface affinity term, b the adsorption capacity, S the amount (mass) of chromium sorbed on the solid phase, and Cf the final equilibrated aqueous concentration. An advantage of the Langmuir model over that of the Freundlich is the incorporation of the capacity term for estimation of overall sorption capacities of the solid phase based on experimental conditions. Significant surface reactivity differences were observed between the surface soils and the aquifer sediments (Table 3). For the soil samples, a significant portion of the surface reactivity can be attributed to reduction. Reduction was defined as the total mass of chromium sorbed (adsorbed + reduced) minus the mass recovered through desorption with phosphate. Table 3 distinguishes between the sorbed fractions attributable to adsorption and reduction for each of the four samples. Also listed are the corresponding Langmuir constants for overall sorption (adsorption + reduction) and capacity terms for sorption (b) and reduction (b_x). The aquifer sediments had less overall sorption capacity and less reduction capacity. Sample 11OC possessed a greater sorption capacity than MW13, but had negligible reduction capacity. As indicated in Table 1, the major differences between the soil and

TABLE 3
Summary of Langmuir Constants and Statistics for Soil and Aquifer Sediment Samples

Sample	Avg. % adsorbed	Avg. % reduced	K_L	b, sorption capacity	Correlation coefficient	b_x, reduction capacity[a]
M1	39	12	0.0525	119	0.9646	13.0
H1	65	7	0.0876	155	0.9718	8.4
11OC	38	1	0.0337	49	0.9136	<1
MW13	19	5	0.0316	14	0.9936	4.1

Note: K_L in liters per kilogram; b and b_x in milligrams per kilogram.

[a] Estimated based on phosphate desorption results.

aquifer sediment samples are clay content, pH, and TOC. The higher clay content, lower pH, and greater TOC of the soils would all favor increased sorption.

Adsorption-reduction experiments for the shop soils (M1, H1) were repeated at pH 3 because other investigators have observed enhanced reduction at low pH, and because that was the chemical environment of the initially disposed Cr (VI) waste stream. Results are depicted in Figure 10 for M1 and H1. At pH 3, there was a significant increase (factor of 10 to 20) in reduction that contributed to more than three times the overall sorption. Even these results underestimate the chromium content in the surface-contaminated soils. A partial explanation for this discrepancy includes alteration of the samples due to drying and sieving primarily causing oxidation of organic matter and ferrous-containing minerals or mineral coatings, with subsequent loss of reduction capacity.

The results of adsorption experiments using background electrolyte compositions with different competing anions are illustrated in Figure 11. Extent of adsorption occurred in the following order: $NaCl > Na_2SO_4 > NaH_2PO_4$ on MW13 aquifer sediment. Chloride, being a nonspecifically sorbed anion, offers little competition to the adsorption of the chromate or bichromate anions; however, significant reductions in adsorption were observed in the presence of sulfate and phosphate. This is consistent with previous observations by Leckie *et al.* (1980) and Zachara *et al.* (1987). Even greater effects have been observed by these investigators at lower pH. The more acidic environment in the uppermost soils, together with the sulfuric acid that was commingled with the chromic acid wastes, would therefore have enhanced the transport of chromate through the soils, particularly where reduction was limited or eventually overwhelmed. Likewise, since about ten times as much sulfate as chromate is currently present in the ground water at the site, adsorption should be reduced and transport favored.

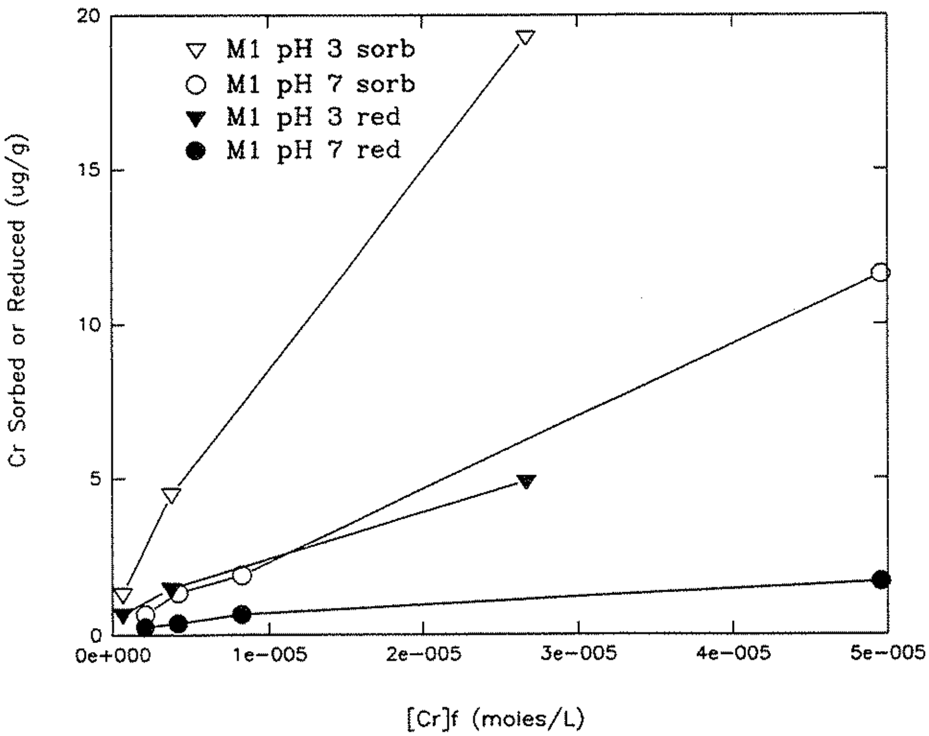


FIGURE 10. Sorption isotherms for soil sample M1 at different pH and showing differences in sorption vs. reduction only. Sorbed values represent total removal of Cr(VI) from solution, whereas the reduction data represent that portion of Cr(VI) removed from solution and not recovered with phosphate desorptions (i.e., reduction as defined in this report).

V. CONCLUSIONS

Figure 12 provides a useful point of reference for a summary of the findings for this study. In the unsaturated zone soils, the chromic acid wastes were immobilized to a significant extent through reduction and subsequent precipitation as primarily a mixed chromium-iron hydroxide coating on primary feldspars, secondary clays, and silica surfaces. While there appears to be sufficient iron for the formation of such insoluble phases in both the soils and the aquifer, reduction is not favored in the saturated zone due to less oxidizable organic matter and a higher pH environment. While the lower natural pH of the soils favors more reduction, the low pH that existed due to the waste stream itself was perhaps more significant. The natural buffer capacity of the soils gradually mitigated this effect as the wastes migrated downward in the soil profile. This, together with the fact that TOC also decreases with depth, would explain why the Cr (VI) fraction increases with depth to the ground water. It is also possible that some kinetic limitations may have existed,

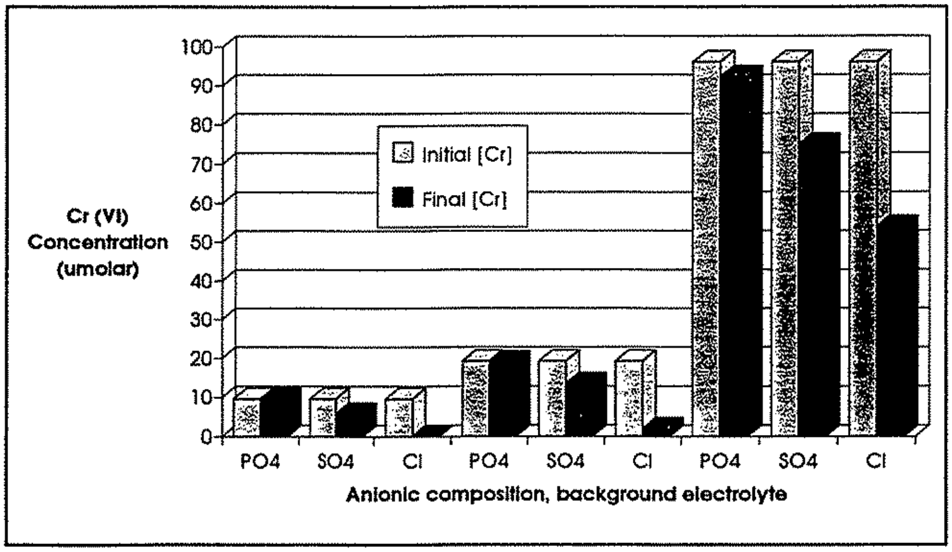


FIGURE 11. Cr(VI) sorption results for MW13 aquifer sediment. Background electrolyte solutions used were 0.005 M NaH_2PO_4, 0.007 M Na_2SO_4, and 0.007 M NaCl.

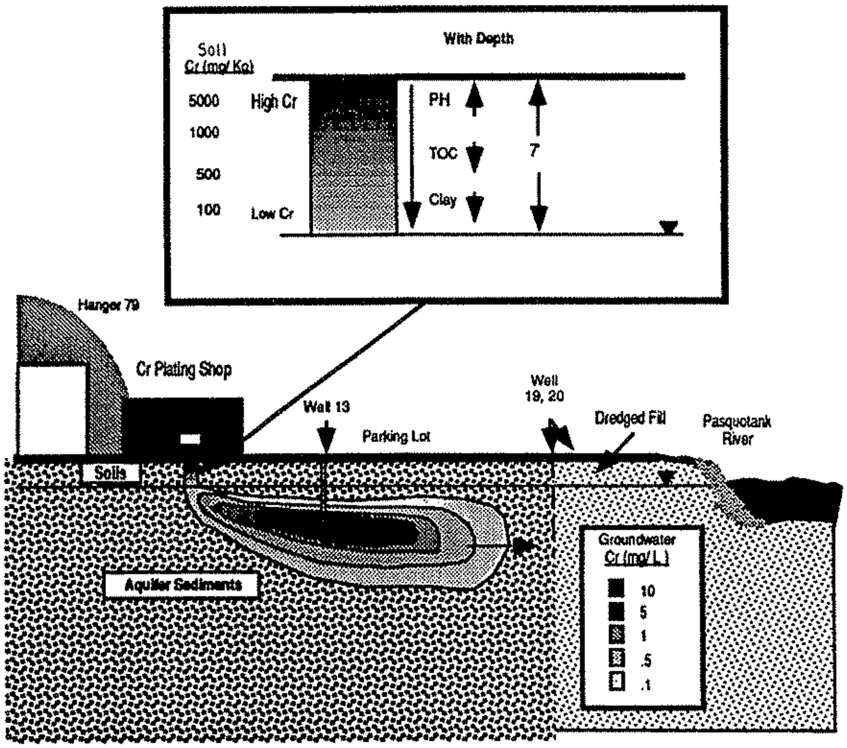


FIGURE 12. Site schematic showing chromium, pH, TOC, and clay content trends in surface soils and relative position of the resultant chromium ground-water plume.

depending on the rate of waste penetration through the unsaturated zone, that is, hydraulic characteristics of the waste stream. As the clay content increased with depth, adsorption of Cr (VI) may also have become more significant as a retardation mechanism. Within the saturated zone, there is very low clay content, higher pH, low TOC, and oxidizing conditions. The chromium present in the ground water has been verified as almost entirely Cr (VI) and appears to be moving almost conservatively with the ground-water flow toward the river.

DISCLAIMER

Although the research described in this article has been funded wholly or in part by the U.S. Environmental Protection Agency, it has not been subjected to the Agency's peer and administrative review and therefore may not necessarily reflect the views of the Agency, and no official endorsement may be inferred.

ACKNOWLEDGMENTS

The authors acknowledge the field support of Frank Beck and Monty Fraser, of the Robert S. Kerr Environmental Research Laboratory, USEPA, and Robert M. Powell and Tim Hensley of ManTech Environmental Technology, Inc. Patricia M. Lindley and Angela Y. Craig of Charles Evans and Associates, Redwood, CA, are acknowledged for their SIMS and XPS analyses, respectively. Terry F. Rees, USGS, Sacramento District, is acknowledged for the SEM-EDS and XRD analyses.

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Missouri Department of NATURAL RESOURCES dnr.mo.gov
Eric R. Greitens, Governor Carol S. Comer, Director

MEMORANDUM

DATE: November 8, 2017

TO: Valerie Wilder, Environmental Manager
Hazardous Waste Program

THROUGH: Brian Allen, Director
Environmental Services Program

FROM: Kevin Thoenen, Laboratory Manager
Environmental Services Program

SUBJECT: Matrix Interference for Chromium Analysis

On October 2, 2017, Environmental Services Program (ESP) staff collected water samples from drinking water sources in the Camdenton area as a part of the Camdenton Sludge Disposal Site study (Job Code: NJ00CAMD). The samples were submitted to the Chemical Analysis Section (CAS) for total and dissolved Arsenic, Barium, Cadmium, Chromium, Copper, Selenium, Lead, and Zinc by EPA Method 200.8 along with Volatile Organic Compounds by EPA Method 524.2. They were assigned CAS laboratory numbers AD08851 through AD08863 (13 samples). The CAS conducted the dissolved metals analysis directly from a field-filtered, acid-preserved aliquot collected from each water source. For the total metals analysis, an aliquot from an unfiltered, acid-preserved sample was acid digested using the procedure outlined in Section 11.2 of EPA Method 200.8 and subsequently analyzed. Acid digestion for the total metals analysis facilitates detecting any metals that are not readily soluble in the acidified, unfiltered aliquot. Therefore, the total metals analysis would expectedly yield higher results than the dissolved metals analysis from the same water source. However, this was not the case for the chromium results reported for this sampling event. In fact, the analysis for dissolved chromium produced positive results for every sample, while the total chromium analysis was unable to detect chromium in any sample with the exception AD08856, which showed 3.25 parts per billion (ppb) chromium.

The CAS received samples from a second sampling event from drinking water sources in the Camdenton area on October 19, 2017. During the second sampling, a filter blank sample was collected to determine whether chromium was introduced as a trace contaminant during the sampling process for the dissolved metals. The filter blank sample is laboratory grade, purified

water subjected to identical sampling processes for dissolved metals including filtration. These samples were assigned CAS laboratory numbers AD09219 through AD09235 (17 samples).

The CAS conducted metals analysis on the samples from the second sampling event in the same manner as the first. The chromium data showed similar trends, where trace levels were found in all of the dissolved samples, while no chromium was detected in the total samples, again with the exception of one sample, AD09225, which showed 4.41 ppb chromium. In addition, the filter blank showed no detectible levels of chromium, eliminating the possibility of trace contamination from the sampling process.

Given the questionable nature of the dissolved chromium data from both sampling events, CAS staff researched possible false positive interferences with chromium by EPA Method 200.8 that would be removed by the digestion process for total metals analysis. Their research found that naturally occurring carbonates could produce trace level false positive results for chromium. The interfering carbonates would be removed with the acid digestion process during total metals analysis, but not in the dissolved metals analysis since it is a direct analysis and doesn't include a digestion step. Therefore, it was determined that the undigested dissolved metal samples would be subject to interference from carbonates not present in the total metals samples resulting in elevated dissolved chromium readings. In response to this information, the CAS reanalyzed the dissolved chromium on all of the samples from the two sampling events by an alternative, approved method (EPA 200.7). EPA Method 200.7 utilizes different technology to detect chromium and is unaffected by naturally occurring carbonates.

The resulting data from EPA Method 200.7 revealed no detectable dissolved chromium in any of the samples from both sampling events, confirming the false positive interference from the EPA Method 200.8 results. In response, the CAS invalidated the dissolved chromium results reported by EPA Method 200.8 for samples AD08851 through AD08863 and replaced them with the dissolved chromium results obtained by EPA Method 200.7. Addendum reports were subsequently generated and issued for samples AD08851 through AD08863. The dissolved chromium results for samples AD09219 through AD09235 were reported using the data from EPA Method 200.7.

We apologize for any confusion this situation has caused. Please contact me if you have any questions or further concerns.

KT:tt

DEPARTMENT OF NATURAL RESOURCES
Division of Environmental Quality

SITE VISIT RECORD

FILE: Camdenton Sludge Disposal Area　　DATE: July 26, 2017

PERSONS INVOLVED:	REPRESENTING:
Amanda Branson	MoDNR, HWP, Superfund
Terry Ball	MoDNR, Private Investigator
Keith Brown	MoDNR, HWP, Superfund
Carl Tidgren	Camdenton Area Landowner

SUMMARY OF CONVERSATION:

Mr. Carl Tidgren was contacted at his home in Camdenton and asked questions regarding past disposal of sewage sludge on his property on Ha Ha Tonka road. Terry Ball asked Mr. Tidgren if he had spread sewage sludge on his properties. Mr. Tidgren responded that he had not personally spread the sludge, but that the city had done so on his properties near the city sewage treatment plant. Mr. Tidgren mentioned that he had horses and a barn on that property and that the sewage sludge improved the fertility of the soil. When asked how long the sludge spreading had occurred Mr. Tidgren replied 'About 5 or 6 years. Tom Emery from the city approached me and said that they wanted to spread sewage sludge on my property." When asked what time period the sludge was applied to his land Mr. Tidgren said that they stopped doing it around 2003 because a neighbor complained about the odor.

Terry Ball asked how often the sewage sludge was applied and Mr. Tidgren replied "Maybe once a month." Terry Ball inquired whether Mr. Tidgren was ever there during the spreading and he responded "Yes, it just looked like black sludge." Mr. Tidgren mentioned that he cuts hay on the property and that horses graze the pastures. "Why does it matter?" Mr. Tidgren asked and he was informed that MoDNR was conducting an environmental assessment related to TCE contamination in Hulett Lagoon. "I never got any sludge from Hulett Lagoon, as far as I know." Mr. Tidgren said. Mr. Tidgren also mentioned that the city would not have been spreading any sludge before the adjacent treatment plant was built and that as far as he knew, all of the sludge spread on his property came from the sewage treatment plant located off of Ha Ha Tonka Road.

Mr. Tidgren described his property where the sludge was disposed. He said that there is a creek that runs along the field and that the city had tried digging down in the creek bed to see how far it is to bedrock and that they went down over 15 feet and never reached bedrock. Mr. Tidgren mentioned that he gave away 5 acres of his land there to his daughter who now lives in a home on site. Terry Ball asked if Mr. Tidgren owned any other properties that the city hauled sewage sludge to and he replied “No.”

ACTION TAKEN:

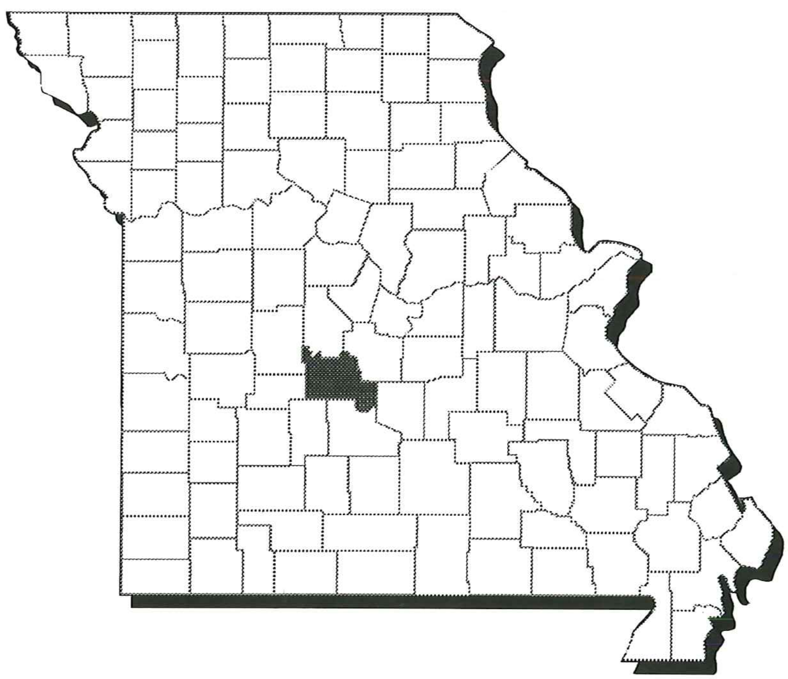
Unless additional information is found indicating that the Camdenton Sewage disposal plant had been contaminated with effluent from Dawson/Modine/ Sundstrand, the sludge disposed on Mr. Tidgren’s property does not appear to pose a direct threat to human health or the environment. Mr. Tidgren was told that he would be informed if there were any new developments, but as of now, MoDNR would not need to sample his property. Mr. Tidgren indicated that he would be cooperative if credible evidence of contamination warranted sampling of his property.

Environmental Specialist	Date of Signature

COMBINED PRELIMINARY ASSESSMENT/SITE INSPECTION REPORT

Camdenton Sludge Disposal Area Site
Camden County, Missouri

March 30, 1999



Missouri Department of Natural Resources
Division of Environmental Quality
Hazardous Waste Program

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DATE: March 30, 1999

PREPARED BY: Valerie H. Wilder
Missouri Department of Natural Resources

SITE: Camdenton Sludge Disposal Area
Camden County

C.A. NUMBER: V997381-98-0

EPA ID. NUMBER:

1.0 INTRODUCTION

Under the authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Missouri Department of Natural Resources (DNR), through a cooperative agreement with the U.S. Environmental Protection Agency (EPA), conducted a Combined Preliminary Assessment/Site Inspection (PA/SI) at the Camdenton Sludge Disposal Area Site in Camden County, Missouri. The Camdenton Sludge Disposal Area is the site where sludge from the Hulett Lagoon, one of the City of Camdenton's wastewater lagoons, was deposited as part of closure. The Hulett lagoon is located in the City of Camdenton, over four miles from the Camdenton Sludge Disposal Area site, and is being investigated separately as the Former Hulett Lagoon site. The Former Hulett Lagoon site has documented trichloroethene (TCE) contamination in the soil and groundwater on-site. Investigation of the sludge disposal area was initiated due to the potential for a release of hazardous substances from the sludge into the environment in the area where it was disposed.

The purpose of this investigation was to collect sufficient information concerning conditions at the site to assess the threat posed to human health and the environment, and to determine the need for additional investigation under CERCLA/SARA or other authority. The scope of the investigation included review of previous file information, sampling of waste and environmental media to document Hazard Ranking System (HRS) factors, and collecting additional non-sampling information. Investigation included site visits on December 1, 16, 1998 and site sampling on January 6, 22, 29, 1999. The PA/SI was initiated on October 27, 1998.

2.0 SITE DESCRIPTION

2.1 Location

The Camdenton Sludge Disposal Area site is located on County Road 5-120, southeast of the Camdenton Memorial Airport. The site is located on city property, but is actually three miles southeast of Camdenton City limits (Reference 3). Geographic coordinates for the site are 37°58'08.7" north latitude and 92°41'14.7" west longitude (Reference 4). The site is in the Northwest 1/4 of the Southeast 1/4 of the Southeast 1/4 of Section 4, Township 37 North, Range 16 West in Camden County. Figure 1 in Appendix A is a site location map (Reference 3).

The Camdenton Sludge Disposal Area can be accessed from the intersection of U.S. Highway 54 and State Route 5 in Camdenton by taking State Route 5 southeast for 4.4 miles to County Road 5-120; take a left onto CR 5-120 (unimproved road) and travel east. The disposal area is 0.3 of a mile down the road on the north side (Reference 5).

The Camdenton area receives an average of 42.32 inches of precipitation annually, and an average of 19 inches of snowfall annually (Reference 6, p. 2). The maximum expected two-year, 24-hour rainfall is approximately 3.5 inches (Reference 7). The average daily temperature during the summer months is 77° F, and the average winter temperature is 35° F (Reference 6, p. 2). The average wind speed and direction is approximately 10 miles per hour from the south (Reference 8, p. 74).

2.2 Site Description

The following description of the Hulett lagoon is included to provide pertinent background information. The former Hulett lagoon is a closed wastewater sewage lagoon that was operated by the City of Camdenton from 1961 to 1988. The lagoon was approximately one acre in size, located in the City of Camdenton, northeast of the intersection of Dawson Road and Sunset Drive. Photos 1 and 2 were taken in October 1974 when the lagoon was operating. Photo 1 shows the north side of the lagoon where an influent pipe from a city sewer line entered the lagoon. Photo 2 shows the south side of the lagoon where an influent pipe from an industrial facility entered the lagoon. A great deal of sludge settling around the influent is visible. In 1989, the lagoon was closed; the water was drained and the sludge was removed (Reference 9, p. 12). Photo 3 was taken during the dewatering process.

The Camdenton Sludge Disposal Area is located in a rural area three miles southeast of Camdenton. The site is an open field with mixed vegetation (Photo 4). At the time of disposal, 42.4 acres were set aside for the sludge application, however, the actual area of sludge disposal may have been considerably less that 42 acres. The sludge disposal area consisted of a designated circular stockpiling area located approximately 150 feet from the county road, and two designated field areas that were to be used for disposal (see Figures

4 and 5 in Appendix A) (Reference 10) (Photos 5, 6). The outline of the stockpiling area is faintly discernable today (Photo 7). The spreader used during the sludge disposal operation was left on-site and is situated approximately 100 yards northwest of the stockpiling area (Photo 8). There are no other structures in the area. Most drainage for the site flows into a low ditch that runs west to east across the southern portion of the site (Photos 9, 10) (Reference 5).

The sludge disposal area is bordered on the south by County Road 5-120; on the north by the Camdenton Memorial Airport; on the west by a residence; and on the east by a wooded area. Access to the site is not restricted. There is no fencing or gates (Reference 5).

2.3 Operational History of Hulett Lagoon

The following section includes pertinent background information regarding operations at the Hulett lagoon. The City of Camdenton, Missouri, currently owns the former Hulett lagoon property as well as the property near the airport where the sludge was disposed. The Hulett lagoon was constructed in 1961 under the State of Missouri Grants Program. The lagoon was constructed of clay, and its berms were approximately 25 feet wide and 15 feet high (Reference 9, p. 12).

The Hulett lagoon was in operation from 1961 until its closure in late 1989. It was one of five municipal lagoons that serviced the City of Camdenton, however, it was the only lagoon that received industrial effluent in addition to domestic sewage. From 1967 through 1986 a nearby manufacturing facility released untreated wastewater and storm water into the lagoon through a series of "mudpits", or sumps, via a storm sewer. Heat transfer components for commercial and automotive industries are manufactured at the facility. The untreated wastewater was known to have contained several hazardous waste streams including corrosive waste, wastewater treatment sludges from electroplating operations, and waste oil. In addition, residual contaminants associated with degreasing operations, including TCE, was discharged into the mud pits and ultimately into the Hulett lagoon (References 9, p. 12; 11, p. 1; 16, p. 8).

The manufacturing facility was owned and operated by Dawson Metal Products, Inc. from 1966 to 1972. Sundstrand Tubular Products, Inc. owned and operated the facility from 1972 to 1990. In 1990 Modine Manufacturing Company bought the facility, and continues operation today (Reference 12). The facility generated TCE waste during degreasing operations from the early 1970's to December 1990 (Reference 13, p. 1).

On May 22, 1984, the City of Camdenton collected samples of the Hulett lagoon water, Sundstrand's influent to the lagoon, housing influent to the lagoon, effluent from the lagoon, and water near Lake of the Ozarks. Results showed 41 parts per billion (ppb) TCE in the Sundstrand influent and 28 ppb TCE in the effluent from the lagoon (Reference 14).

On July 19, 1984, additional samples of Sundstrand's effluent and lagoon water were collected. This Sundstrand effluent sample showed 4,900 ppb TCE in addition to 7,600 ppb total chromium, 29,000 ppb total copper, and 1,400 ppb total zinc. The sample from the lagoon showed 500 ppb TCE, 500 pbb total chromium, 200 ppb hexavalent chromium, 4100 ppb total copper and 230 ppb total zinc (Reference 15).

In 1988, the City of Camdenton began closure of the Hulett Lagoon pursuant to an Industrial Development Grant overseen by DNR's Water Pollution Control Program (WPCP). As per DNR guidelines for closing out municipal lagoons, sampling and analysis of the sludge in the lagoon was limited to metals and other parameters such as total solids. High levels of chromium, lead, and nickel were detected (Reference 16). DNR offered the City officials several options to consider in completing the closure of the lagoon (Reference 17). The option chosen and implemented by the city was subsurface application of the sludge from the lagoon to a sludge disposal site owned by the city. DNR approved the sludge disposal plan on February 22, 1989 (Reference 18).

The city's engineering consultant, Missouri Engineering Corporation, supervised the lagoon closure project. In June 1989, McCormick Gravel & Excavating of Versailles, Missouri was awarded the contract for the removal, stockpiling and disposal of sludge from the lagoon. The contract included lagoon dewatering, preparation, transportation, and stockpiling of the sludge, as well as disposal by land application at the sludge disposal area (References 10; 19).

The specifications called for the contractor to pump the water from the lagoon and discharge it into the existing sewer manhole approximately 100 feet away (Reference 10). The process of removing the sludge at the lagoon began on July 11, 1989 and was completed sometime in late September 1989. Lime was added to the sludge at the lagoon to raise the pH and immobilize the metals. The project contract was originally written with an estimate of 1,500 cubic yards of sludge to be removed. However, due in part to an unusually high amount of rain during the removal process, the sludge did not dry out and shrink, as it should have. In addition, the rainfall caused the sludge to be spread across the lagoon contaminating more soil. The lagoon had to be pumped again and the sludge allowed to dry. A small amount of soil then had to be removed along with the sludge. When that portion of the project was completed, an estimated 2,395 cubic yards of sludge had been removed (References 20; 21; 22). The berms of the lagoon were turned in and mixed in a 1 to 1 ratio (Reference 23).

2.4 Camdenton Sludge Disposal Site History

Activities at the Camdenton Sludge Disposal Area site began in July 1989. Prior to this, the site was owned by the city, and was part of the airport, but was not used for any particular purpose. The sludge was transported by truck to the designated area off County Road 5-120, which is south of the Camdenton Memorial Airport runway. The sludge was stockpiled in the designated storage facility region, a circular area 120 feet in diameter

located 150 feet from County Road 5-120. Figure 4 in Appendix A is a planning map from the City of Camdenton's Specifications and Contract Document that shows the sludge disposal area near the airport. In December 1989, after allowing the sludge to dry, the contractor began spreading the sludge with a dry sludge applicator onto the designated fields at the airport, mixing it with additional soil and discing the sludge into the ground. During the mixing, soils tests were reportedly taken to demonstrate that the loading was below the specified levels. (Reference 22). Figure 5 in Appendix A is a wider view planning map that shows the designated fields to be used for disposal.

The mixing, spreading and discing continued through March 1990. Apparently, rain and snow delayed completion of the spreading (Reference 22). City employees who observed some of the spreading activity reported the sludge was more difficult to spread evenly than was originally anticipated. It didn't dry out completely and would stick together in clumps. Near the end of the process, it was reported that the last several piles of sludge transported to the area were simply dumped into the ditch located about 50 feet north of the circular storage area. It was not spread, mixed or disced (Reference 5).

In March 1990, the fields were seeded with a mix of Timothy and Fescue grasses in order to provide ground cover and prevent erosion. In April 1990, the pH of the soils in the fields was tested to ensure a level of 6 was achieved. Anything below 6 would be mixed with lime to raise the pH (Reference 22).

<u>Referral of Former Hulett Lagoon to Superfund Section</u>

On September 8, 1998 the Permits Section of the Hazardous Waste Program formally referred investigation of the former Hutlett Lagoon and the Camdenton Sludge Disposal Area to the Superfund Section of the HWP. The Permits Section is currently negotiating a Corrective Action Abatement Order on Consent (AOC) with the Modine Manufacturing Company to investigate contamination present on the Modine property. Investigation of the Hulett Lagoon is not included in the AOC, however, because in addition to receiving wastewater from the facility at 179 Sunset Drive, the lagoon also received domestic sewage from the surrounding residences. A dye trace study of the City of Camdenton's sewer system performed by the Division of Geology and Land Survey (DGLS) on August 5, 1998, verified that facility wastewater mixed with domestic sewage prior to entering city property (Reference 24).

According to 40 CFR 261.4(a)(1), domestic sewage and any mixture of domestic sewage and other wastes that pass through a sewer system to a publicly owned treatment works (POTW) are not considered solid wastes, and thus would not be considered hazardous wastes. The facility that disposes of such wastes is excluded from RCRA permitting requirements, which is why the Hulett Lagoon site was referred to Superfund to be addressed under CERCLA. CERCLA has no such exemption.

Although the Former Hulett Lagoon and the Camdenton Sludge Disposal Area sites are related to each other with respect to their history and origin of contamination, they are more than 4.5 miles apart, which warranted investigating them as two separate sites.

2.5 Waste Characteristics

Analytical results from soil sampling show chromium contamination above background and above Superfund Chemical Data Matrix (SCDM) health-based benchmarks. Copper, lead, mercury, nickel, selenium, silver, ethylbenzene, toluene, and total xylenes were detected above background, but none of the levels exceeded SCDM benchmarks.

Chromium is a naturally occurring metal in the environment. It binds to soil and other materials in water and settles to the bottom. A small amount may dissolve in the water. Soluble chromium compounds can remain in water for years before settling to the bottom. Fish do not accumulate much chromium in their bodies from water. Most of the chromium in the soil does not dissolve easily in water and can attach strongly to the soil. A small amount in the soil will dissolve in water and can move deeper in the soil to underground water. In humans, very little chromium enters the body through skin contact unless the skin is damaged. Low levels of chromium exposure will eventually be passed through the body. Chromium is classified as a carcinogen (certain compounds), hazardous substance (certain compounds), hazardous waste constituent and priority toxic pollutant by EPA (References 25, pp. 1-4; 26, p. 243)

Trichloroethene
Information regarding TCE is included because it is a contaminant of concern at this site even though none was detected in the soil samples on-site. The lagoon is known to have been contaminated with TCE; it is suspected the sludge did contain TCE at one time. TCE was detected in private drinking water wells near the sludge disposal area.

TCE is a nonflammable, colorless liquid at room temperature with a somewhat sweet odor and sweet, burning taste. The manmade chemical does not occur naturally in the environment. TCE is now mainly used as a solvent to remove grease from metal parts. It is also used as a solvent in other ways and is used to make other chemicals. TCE evaporates easily into the air but can persist in the soil and groundwater. Once TCE is in surface water, much of it will evaporate into the air. It will take days to weeks to break down in surface water; in groundwater, the breakdown is much slower because of the slower evaporation rate. Very little TCE breaks down in the soil, and it can pass through the soil into underground water (Reference 27, pp. 1, 2).

TCE can enter the body from breathing air or drinking water containing TCE. It can also enter through the skin, but not as easily as by breathing or drinking. If the chemical is inhaled, about half will enter the bloodstream and organs; the remaining is exhaled. If TCE is swallowed, most will be absorbed into the blood. The liver changes most of the TCE to other chemicals and the majority of these breakdown products leave the body in the urine

within a day. Some of the common symptoms to TCE exposure (usually at high levels) are headaches, dizziness, and rashes. Laboratory animals that were exposed to moderate levels of TCE had enlarged livers, and high-level exposure caused liver and kidney damage. However, it is not known if these changes would occur in humans. TCE is considered an animal carcinogen (Reference 27, pp. 1-4).

TCE is known as a Dense Nonaqueous Phase Liquid (DNAPL). DNAPLs are separate-phase hydrocarbon liquids that are denser than water. DNAPLs can exist in the soil/aquifer matrix in free-phase form or in residual form. When released on the ground's surface, free-phase DNAPLs move downward through the soil matrix under the force of gravity or laterally along the surface of sloping fine-grained stratigraphic units. As free-phase DNAPLs move, residual amounts are trapped in pores and/or fractures by capillary forces. Trapped DNAPLs are known as residual saturation. This residual saturation is a function of the physical property of the DNAPL and the hydrogeologic characteristics of the soil/aquifer medium, which typically ranges from 5-50% of total pore volume (Reference 28).

Most DNAPLs undergo only limited degradation in the subsurface and persist for long periods of time, while slowly releasing soluble organic constituents to groundwater through dissolution. Dissolution may continue for hundreds of years under natural conditions before the DNAPL is dissipated (Reference 28).

3.0 WASTE/SOURCE SAMPLING

3.1 Sample Locations (Reference 29)

PA/SI soil sampling in the sludge disposal area was conducted on January 22, 1999. Figure 2 in Appendix A is a site map that shows collection location of all soil samples collected in the sludge disposal area. A membrane interface probe (MIP), equipped with a photo ionization detector (PID) and a flame ionization detector (FID), was employed to generate soil gas data of the subsurface within and surrounding the boundaries of the former lagoon area. The soil gas data was used, in part, to determine actual sampling locations.

Ten soil borings (Hulett-11 through Hulett-20) were drilled to collect eight soil source samples from the sludge disposal area and two background samples from outside the area. Five of the nine borings (Hulett 12, 13, 14, 18, 19) were focused in the area near the main ditch. The source samples were collected generally from two depth zones. Near surface samples (0.5'-1') were collected in an attempt to locate actual sludge material. Subsurface samples (5'-8') were collected in an attempt to determine whether any potential contamination from the sludge may have migrated downward. Refusal, meaning bedrock, was generally encountered at depths ranging from 5 to 8 feet. The background boring was drilled just north of County Road 5-120 approximately 25 feet southwest of the sludge

disposal area. The background samples were collected from a 0.5'-1' depth and 5.5'-6' depth, which corresponds approximately with the depth zones of the source samples.

3.2 Analytical Results (Reference 29)

Reference 29, Appendix B contains the MIP data logs generated for each boring. The logs indicate detections noted on the MIP's PID (identified as "Detector 1") and the FID ("Detector 2"). Small detections on the MIP's PID and FID in borings Hulett 12, 18 and 19 indicated there may be some volatile organic compounds present. Detections only on the FID for borings 15, 16 and 17 indicated methane might be present.

Table 1, on the following page, presents selected analytical results for all soil samples collected by DNR as part of the PA/SI. All soil samples were analyzed for total metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, and silver) and VOCs. Chemicals that were non-detect in all samples are not listed in the table. If any sample's total analyte levels exceeded 80% of 20 times the Toxicity Characteristic Leaching Procedure (TCLP) regulatory limit for a particular analyte, TCLP analysis was performed on that sample.

Green sludge material was encountered in borings Hulett 12 and Hulett 19, from the ditch area. Analytical results from samples 991478 and 991483 (0.5'-1' depth) showed total levels of chromium, copper, lead, and nickel significantly above background, although none of the TCLP results exceed regulatory limits. Only the chromium concentrations exceed SCDM benchmarks; only one chromium concentration exceeds the Missouri Department of Health's published Any-Use Soil Level (ASL) for chromium. Low levels of ethylbenzene, toluene and total xylenes were detected in sample 991483.

3.3 Waste/Source Conclusions

Over 2,000 cubic yards of sludge from the Hulett lagoon was deposited in a 20-40 acre tract at the Camdenton Sludge Disposal Area site. The majority of PA/SI sampling focused on the region near the main ditch in the disposal area. Reportedly, several loads of sludge were deposited into this ditch near the end of the project without any mixing, discing or spreading. Recognizable sludge material was encountered in two soil borings from the ditch. Levels of chromium, copper, lead and nickel were documented significantly above background in these two samples. Chromium, however, was the only compound detected that was present at a level exceeding the SCDM benchmarks and the MO ASL. TCE was not detected in any of the eight soil samples collected from the disposal area.

TABLE 1: SELECTED ANALYTICAL RESULTS FROM SOIL SAMPLES COLLECTED IN/NEAR THE CAMDENDTON SLUDGE DISPOSAL AREA

All results in parts per million (ppm) * soil saturation level substituted for ASL NA - not analyzed NL - not listed
Underlined results are those that are three times above background or above the detection limit if the background concentration is below the detection limit
Bolded results are those that are above background and exceed SCDM Benchmark and/or MO ASL

	Hulett-11	Hulett-12		Hulett-17	Hulett-18	Hulett-19			Hulett-20		SCDM Bnchmrk	MO ASL	MO CALM C_{LEACH}
	0.5' – 1'	0.5' – 1'	8.5' – 9'	0.5' – 1.5'	5.5' – 6'	0.5' – 1'	7' – 7.5'	7' – 7.5'	0.5' – 1'	5.5' – 6'			
	991476	991478	991477	991479	991480	991483	991481	991482	991484	991485			
	stockpile	sludge				sludge		replicate	background				
METALS													
Arsenic, total	7.46	8.78	4.98	5.97	7.08	19.7	4.94	5.76	8.74	34	0.0043	11	NL
Barium, total	170	280	139	105	93.7	253	69	82.6	206	195	5500	3900	1650
Cadmium, total	<0.2	0.782	<0.2	<0.2	0.216	1.55	<0.2	<0.2	<0.2	0.409	39	28	11
Chromium, total	33.1	**1640**	27.5	34.7	74.8	**7830**	38.8	43.9	38.1	110	390	5600	38
Chromium, TCLP	NA	0.0463	NA	NA	NA	0.041	NA	NA	NA	<0.004			
Copper, total	9.45	1890	10.4	6.79	7.12	11200	8.67	11.4	14.6	32	NL	NL	NL
Lead, total	21.8	66.2	19.2	17.3	19.4	121	13.5	16.6	26.3	67.6	NL	240	NL
Lead, TCLP	NA	NA	NA	NA	NA	<0.0411	NA	NA	NA	NA			
Mercury, total	<0.04	0.314	<0.04	<0.04	<0.04	0.195	<0.04	<0.04	0.0819	<0.04	23	17	3.23
Nickel, total	12.3	29.9	15.5	11.4	9.33	129	8.4	9.4	15.5	42.7	1600	1100	170
Selenium, total	<1	<1	<1	<1	<1	1.03	<1	<1	<1	<1	390	280	4.37
Silver, total	<1	<1	<1	<1	<1	3.17	<1	<1	<1	<1	390	280	255
VOCs													
Ethylbenzene	<0.025	<0.025	<0.025	<0.025	<0.025	0.023	<0.025	0.018	<0.025	<0.025	58	340	0.097
Toluene	<0.025	<0.025	<0.025	<0.025	<0.025	0.03	<0.025	<0.025	<0.025	<0.025	58	340	0.097
Total Xylenes	<0.025	<0.025	<0.025	<0.025	<0.025	0.084	<0.025	<0.025	<0.025	<0.025	58	340	0.097

4.0 GROUNDWATER PATHWAY

4.1 Hydrogeologic Setting (Reference 30)

Stratigraphic Units

A stratigraphic column (Table 2 on page 14) has been tabulated based upon the stratigraphy of nearby wells. The youngest bedrock formation beneath the site is the Ordovician-age Roubidoux Formation, assigned to the Canadian Series. The Roubidoux Formation consists of dolomite, sandy dolomite, and sandstone. In the Camdenton area, soluble portions of the Roubidoux have generally been removed by dissolution. Nearby well logs indicate that the Roubidoux Formation may consist of clayey residuum and sandstone, with only small lenses of carbonate rock remaining. In the headwaters of Racetrack Hollow, approximately ½ mile west of the site, erosion has completely removed the Roubidoux Formation and the underlying Gasconade Dolomite is exposed at the surface. Approximately 1½ miles northeast of the site, Jefferson City Dolomite exposures overlie the Roubidoux Formation.

Underlying the Roubidoux Formation, the Gasconade Dolomite consists of cherty dolomite and is estimated to be approximately 280 feet thick in the vicinity of the site. A basal unit of the Gasconade Dolomite, known as the Gunter Sandstone Member, commonly separates the Ordovician- and Cambrian-age strata. The Gunter Sandstone is approximately 25 feet thick in the Camdenton Airport area.

Cambrian rocks in the Camdenton area were deposited in a complex depositional environment. The Camdenton Sludge Disposal Area is located near the western margin of a Cambrian-age intrashelf sedimentary basin known as the Central Missouri Basin. During Cambrian time, the Camdenton area was part of an emerging tectonic feature known as the Lebanon Arch. The north-south trending Lebanon Arch consists of carbonate platform rocks, that in some areas, thin over Precambrian highlands. The boundary between the Central Missouri Basin and the Lebanon Arch is transitional and poorly defined. Dramatically different lithologies and abrupt facies changes are depicted in area well logs. In general, more shaly, basinal rocks to the east pinch-out against the Lebanon Arch.

Because of the tectonic setting, Cambrian beds in the Camdenton area are difficult to categorize, and "layer-cake" stratigraphy should not be assumed. The following descriptions are simplified. The upper-most Cambrian unit in the area is the Eminence Dolomite, which consists of approximately 240 – 635 feet of dolomite with minor amounts of chert. The Eminence Dolomite is underlain by about 25 - 230 feet of Potosi Dolomite, which consists of dolomite, chert, and drusy quartz. Beneath the Potosi Dolomite, in descending order, are the Derby-Doerun Dolomite, the shaly Davis Formation, the Bonneterre Formation, and the Lamotte Sandstone. The entire Cambrian section is estimated to be over 1,150 feet thick.

<u>Aquifers</u>
The Ozark Aquifer, which includes all bedrock units above the Cambrian-age Derby-Doerun Dolomite, is the shallowest aquifer beneath site. The Ozark Aquifer is considered exposed at the surface at the Camdenton Sludge Disposal Area. The total thickness of the aquifer is approximately 950 feet. Each of the units which comprise the Ozark Aquifer have individual characteristics that control their water-bearing capabilities; however, in general, the Ozark Aquifer produces good-quality water, with production rates generally proportional to well depth.

There can be perhaps as many as three separate potentiometric surfaces within in the Ozark Aquifer in upland areas such as the Camdenton Sludge Disposal Area. Water levels in upland wells completed in the Roubidoux Formation range from 18 to 205 feet below the surface. However, it is possible that the Roubidoux Formation present beneath this particular site is too thin to contain groundwater. Water levels in upland wells completed in the Gasconade Dolomite range from 14 to 300 feet below the surface, with an average depth to water of 150 feet. Water levels in upland wells completed in the Eminence Dolomite and deeper formations range from 15 to 407 feet below the surface, with an average depth to water of 200 feet. The multiple water-level phenomenon common in upland areas suggests significant local recharge to the deeper portions of the Ozark Aquifer.

Differences in head between shallow and deep portions of the Ozark Aquifer are typical in upland areas such as the Camdenton Sludge Disposal Area. The site is expected to be a groundwater recharge zone. Extensive pumping of deeper groundwater can increase the downward vertical gradient. Camden County PWSD #2 Well #1 is reportedly used only once per week with the bulk of water being supplied by Well #2 located approximately 3 miles south of the Camdenton Sludge Disposal Area. Nearby domestic wells can also contribute to an increase in downward gradient. Pumping rates at the Camden County PWSD #2 Well #1 may be high enough to engulf the site within a cone of depression. The radius of influence of nearby production wells should be determined.

Because detailed hydrogeologic studies have not been conducted at the site, groundwater flow directions within the bedrock can only be approximated. According to the potentiometric map of the Roubidoux-Gasconade sequence in "Hydrology of Carbonate Terrane – Niangua, Osage Fork, and Grandglaize Basins, Missouri", shallow groundwater beneath the site could flow eastward toward Dry Auglaize Creek. However, according to Figure 15 "Generalized direction of groundwater flow in the Niangua, Osage Fork, and Grandglaize basins" published in the Water Resources Guide No. 35, groundwater beneath the site could flow northwestward toward the Niangua Arm of the Lake of the Ozarks. Furthermore, dye traces have shown that surface water lost in Dry Auglaize Creek can cross the surface water divide and discharge into the Niangua River, northwest of the site. It is possible that both groundwater flow directions are correct. Shallow groundwater may flow toward Dry Auglaize Creek, while deeper groundwater may be diverted into the Niangua Basin.

Monitoring well nests are needed to accurately determine the magnitude of the downward vertical gradient. The upper Gasconade Dolomite *may* inhibit the downward migration of contamination. However, fracturing and karst development may have resulted in a local increase in permeability within the otherwise relatively tight upper Gasconade Dolomite.

The Gunter Sandstone is generally highly porous and permeable and is an important source of domestic groundwater supplies in the area. Because the Gunter Sandstone generally yields adequate domestic water supplies, few private wells in the area penetrate the underlying Cambrian Formations. However, municipal wells in the Lake of the Ozarks area are generally cased through the Gunter Sandstone, in order to avoid possible bacterial contamination.

The Eminence and Potosi Dolomites are a major source of municipal drinking water throughout the Ozark area, including the City of Camdenton. The Eminence Dolomite is differentiated from the underlying Potosi Dolomite by the lack of druse. A druse is a rock cavity encrusted with finely crystalline quartz. The druse-rich Potosi Dolomite is the most permeable geologic unit within the Ozark Aquifer and generally has an extensive network of karstic channels.

The shallowest reliable aquitard beneath the site is the St. Francois Confining Unit, approximately 1,150 feet below the surface. The St. Francois Confining Unit separates the Ozark Aquifer from the deeper St. Francois Aquifer. The St. Francois Aquifer includes the Cambrian-age Bonneterre Formation and Lamotte Sandstone. The St. Francois Aquifer is not used as a water source in Camden County. Water losses in the Lamotte Sandstone are common in some parts of the Ozark Region, although the phenomenon is poorly understood. Outside the St. Francois Mountain area, few water wells penetrate the Lamotte Sandstone, since yields may actually be reduced. Groundwater flow directions in the deeper St. Francois Aquifer are generally unknown and may be complicated.

Baseline water-level and pumping rate data need to be collected before informed decisions about groundwater movement in the Camdenton subsurface can be made. Static water levels should be measured at least monthly at any inactive wells. Detailed records of active wells should include volume of water pumped, length of pumping cycles, and drawdown measurements.

There are no aquifer discontinuities within a four-mile radius of the site. Folds and faults in the area cannot be considered aquifer discontinuities because their effects on groundwater movement are so poorly understood. Older faults have more highly-developed solution channels and may, therefore, act as groundwater conduits. Younger faults can actually act as aquitards, inhibiting groundwater flow.

Wellhead Protection Area

The Camdenton Sludge Disposal Area is located in Area 1, as designated by the DGLS Wellhead Protection Section. Since September 1987, Area 1 bedrock wells have been required to have 80 feet of casing and penetrate at least 30 feet of bedrock.

Karst Features

The Camdenton Sludge Disposal Area is considered karst. Significant karst features are present within a four-mile radius of the site. Dissolution has caused the carbonate aquifers to be extremely heterogeneous.

Geologic Structures

Geologic structures can influence groundwater movement. The effects of the structural deformation on groundwater are poorly understood, but the faulting and folding has probably increased hydraulic conductivities in some areas. The northwest-trending structures in the Camdenton area tend to be older than northeast-trending structures. Northwest-trending structures may act as groundwater conduits.

Faults and folds have been mapped within four miles of the site. Well log data suggest unmapped faults may also affect the area. A circular area of complex brecciation, known as the Decaturville Structure, lies just southwest of the four-mile target radius. The Decaturville Structure is part of the Decaturville-Crooked Creek axis, a series of highly-faulted areas stretching eastward into Kentucky. The Mine Hollow Fault is located approximately 2/3 mile southeast of the Camdenton Sludge Disposal Area. The fault appears to radiate from the Decaturville Structure. The Mine Hollow Fault has a northeast trend and is downthrown approximately 60 feet to the northwest.

The axis of a northwest-trending syncline, called the Racetrack Hollow Syncline, has been mapped less than two miles west of the Camdenton Sludge Disposal Area. The Red Arrow Fault is located less than three miles southwest of the site. The Red Arrow Fault strikes northwest and, in general, the southwest side is downthrown approximately 100 feet. However, geology along the fault zone is complicated. LOGMAIN Well # 28602 is located along the western portion of the fault zone and indicates significant upward movement. Ha Ha Tonka Spring is located along the trace of the Red Arrow Fault.

The poorly defined Proctor anticline runs across Camden County. The Proctor Anticline changes to a fault in southern Camden County. The Proctor Fault has been mapped less than four miles northeast of the Camdenton Sludge Disposal Area. The structure is probably related to a rejuvenated Precambrian fault.

Table 2: Stratigraphic Column for the Camdenton Sludge Disposal Area, Camden County (after Harvey et. al.,1983)

System	Aquifer Group	Approximate Site – Specific Thickness (ft)	Formation	Hydraulic Conductivity (cm/sec)	Regional Thickness (ft)	Dominant Lithology	Water-bearing Character
Quaternary		10	Colluvium and residuum		0-90	Regolith of residual clay, sand, chert pebbles and cobbles	May contain small amounts of perched water.
Ordovician	Ozark Aquifer	50	Roubidoux Formation	10^{-3}	0-90	Clayey residuum, sandstone and sandy dolomite	Not present in sufficient thickness in the Camdenton area to produce usable quantities of water.
		280	Gasconade Dolomite	10^{-6}	300-385	Cherty dolomite, minor sandstone, and shale	Yields moderate to large quantities of water to wells. Yields range from 20 to 75 gpm. Less-permeable Upper Gasconade may act as a leaky confining unit.
		25	Gunter Sandstone Member	10^{-4}	10-45	Sandstone	Contributes moderate to large quantities of water. Most wells open to other formations.
Cambrian		550?	Eminence Dolomite	10^{-5}	240-635	Cherty dolomite	Yields 6-100 gpm, the average being about 20 gpm
		50?	Potosi Dolomite	10^{-4}	30-330	Dolomite; contains abundant quartz druse	Yields large quantities of water to wells. Yields range from 100 to 750 gpm.
	St. Francois Confining Unit	80	Derby-Doerun Dolomite	10^{-7}	80?-215	Shaley dolomites and shale	Reliable aquitard.
		80	Davis Formation	10^{-7}	50-380?		
	St. Francois Aquifer	90	Bonneterre Formation	10^{-5}	85-200	Dolomite and limestone	Generally used only in outcrop areas. May contribute additional 100-200 gpm to wells open to other formations.
		300	Lamotte Sandstone	10^{-5}	140-300	Sandstone and arkosic conglomerate	
Precambrian	Basement Confining Unit					Igneous and metamorphic rocks	Does not yield water to wells in this area

4.2 Groundwater Targets

Groundwater use within four miles of the site is extensive. At least 1,888 people are served by public wells in the area and an estimated 210 people are served by private wells. A detailed description of the well use follows.

Public Drinking Water Wells
Public Water Supply District (PWSD) #2 of Camden County has two drinking water wells within four miles of the site. Well #1 is located just east of Highway 5 at the Camdenton Memorial Airport, approximately 0.6 of a mile northwest of the sludge disposal area. The well was drilled in 1974 to a total depth of 848 feet with 330 feet of 6 inch steel casing. The pump is set at 415 feet. Records show the well only yields 83 gpm. PWSD #2 personnel reported that Well #1 is used as a reserve well, and is only turned on once a week for a maintenance check. Well #2 is located just east of Highway 5, approximately 3.1 miles south-southwest of the site. Well #2 was drill in 1995 to a total depth of 1,100 feet with 425 feet of 8 inch steel casing. The pump is set at 275 feet (Reference 31). PWSD #2 personnel reported that Well #2 is the primary well that supplies 99% of the water for the district. (Reference 5). Camden County PWSD #2 serves 800 people (Reference 32, p. 60).

The Southway Terrace Mobile Home Park well is located on Highway 5, approximately 2.2 miles northwest of the site. The well was drilled in 1970 to a total depth of 550 feet with 350 feet of six inch steel casing (Reference 33). This well serves 85 people (Reference 32, p. 120).

The City of Camdenton's Rodeo well is located on Rodeo Road in the City of Camdenton, approximately 3.6 miles northwest of the site. The Rodeo well was drilled in 1961 to a total depth of 940 feet with 450 feet of eight-inch steel casing. The pump is set at 420 feet. The yielding strata is the Potosi Dolomite. Records show the well yields 380 gpm (Reference 34). The Rodeo well would serve an apportioned 993 people (Reference 32, p. 14).

TABLE 3: PUBLIC WELLS WITHIN A 4-MILE RADIUS OF THE CAMDENTON SLUDGE DISPOSAL SITE		
Distance from Site	Name of Well	No. of People Served*
1/2 - 1	Camden County PWSD #2 Well #1	Reserve Well Only
2-3	Southway Terrace MHP	85
3-4	Camden County PWSD #2 Well #2	800
	City of Camdenton's Rodeo Well	1,003
TOTAL		1,888
* Reference 32, pp. 14, 33, 120, 131		

Private Drinking Water Wells
Within four miles of the site, there are 87 wells recorded in the DGLS databases. The LOGMAIN database contains information on older wells. The DGLS Well Wellhead Protection Section's Water Well Information System (W.I.M.S) database contains

information on wells drilled since 1987. The vast majority of the wells on record are domestic supply wells. Some wells may no longer be active, and many active wells may not be recorded in DGLS databases. Table 4 presents the breakdown of private wells within four miles of the site (Reference 30). The population served by private wells was calculated using the estimated average persons per household in Camden County - 2.41 (Reference 35).

TABLE 4: PRIVATE WELLS REGISTERED WITH DNR WITHIN A 4-MILE RADIUS OF THE CAMDENTON SLUDGE DISPOSAL SITE

Distance From Site	Number of Private Wells	Estimated Population Served
0 - 1/4	1	2
1/4 - 1/2	2	5
1/2 - 1	2	5
1-2	17	41
2-3	29	70
3-4	36	87
TOTAL	**87**	**210**

4.3 Previous Sampling

On August 3, 1998, sample 98-M225 was collected from a drinking water well at 3499 RR3, located on County Road 5-120 approximately 0.15 of a mile west-southwest of the Camdenton Sludge Disposal site. The homeowner had requested the City of Camdenton collect the sample because he was concerned about the proximity of his well to the sludge disposal area. The City of Camdenton's Public Works Director collected the sample, and sent it to DNR for analysis. The sample was analyzed for VOCs. TCE was detected at 13.1 ppb and cis-1,2-dichlorothene was detected at 0.6 ppb (Reference 36).

This result caused concern, and DNR requested a second confirmatory sample be collected. On August 23, 1998, the Public Works Director collected sample 98-M286 from the well at 3499 RR3. For this sample, the well was evacuated for at least 20 minutes. The sample was non-detect for all VOCs (Reference 37).

4.4 PA/SI Sampling Locations

Groundwater samples for the PA/SI were collected on January 6 and 29, 1999. One public water supply well and three private drinking water wells were sampled. Figure 3 in Appendix A shows sample locations for all groundwater samples collected as part of the Camdenton Sludge Disposal PA/SI (Reference 29).

<u>DNR Sampling - January 6, 1999</u> (Reference 29)
Three private drinking water wells near the site were sampled on January 6, 1999. Two samples were collected from the well at 3499 RR3 (County Road 5-120), the one previously sampled in August 1998. The first sample was collected after evacuating the well for approximately 30 seconds. The second sample was collected after evacuating the

well for approximately 5 minutes. This technique was utilized due to the discrepancy in analytical results from previous samples that were collected after different intervals of evacuation. No information is known about this well.

The second well sampled was at the 3496 RR3 residence, located on County Road 5-120 approximately 0.25 of a mile southeast of the site. Only one sample was collected from this well. The well is reported to have been drilled in 1971 to a total depth of 528 feet with 40 - 45 feet of casing and the remainder open hole. The third well sampled was at the residence located directly across the road from the 3496 RR3 (County Road 5-120) residence. Only one sample was collected from this well. The well is reported to have been drilled sometime between 1956-1958 to a total depth of 280 feet.

<u>Private Sampling - January 6, 1999</u> (Reference 38)
Later in the day on January 6, after DNR samples were collected from the residences at 3496 and 3499 RR3, the property owner at 3496 RR3 collected additional water samples from his well and the well at 3499 RR3 for independent analysis. The samples were analyzed at Environmental Analysis South, Inc. in Cape Girardeau, MO. The cost for analysis was paid for by the home owners. The samples were analyzed for TCE. The sample result from the well at 3499 RR3 showed 20 ppb TCE; the sample result from the well at 3496 RR3 showed 21 ppb.

<u>DNR Sampling - January 29, 1999</u> (Reference 29)
Additional sampling was conducted at the 3496 and 3499 RR3 wells due to the discrepancies in analytical results from the samples collected on January 6, by the property owner and analyzed by Environmental Analysis South, Inc., and those collected and analyzed by DNR.

Both wells were resampled by DNR on January 29, 1999. Again, due to theories that the TCE was only being detected after a certain amount of purging, several samples were collected from each well at various intervals of evacuation. Samples were collected from the well at 3499 RR3 at three intervals of evacuation: 15 minutes, 45 minutes and 75 minutes. Four of the samples (including a duplicate) were marked for analysis by DNR. Two split samples were collected and marked for analysis by Environmental Analysis South, Inc. One split sample was collected and marked for analysis by Environmental Health Laboratory.

Samples were collected from the well at 3496 RR3 at four intervals of evacuation: 15 seconds, 15 minutes, 45 minutes and 75 minutes. Four of the samples were marked for analysis by DNR. Two split samples were collected and marked for analysis by Environmental Analysis South, Inc. One split sample was collected and marked for analysis by Environmental Health Laboratory.

Also sampled on January 29, 1999 was the Camden County PWSD #2 Well #1. One sample, 991496, was collected from the well after evacuating the well for 10 minutes.

4.5 Analytical Results (References 29; 38)

Private Drinking Water Wells

3496 RR3 Well

Sample 991456, collected by DNR from the 3496 RR3 residence on January 6, 1999, was analyzed by DNR for total metals (arsenic, barium, cadmium, chromium, copper, mercury, nickel, lead, selenium, silver) and VOCs. Barium was detected at 81.7 ppb, copper was detected at 12.8 ppb, and lead was detected at 17.7 ppb. The sample was non-detect for all VOCs.

As stated previously the sample collected by the home owner at 3496 RR3 (430115), on January 6, 1999, was analyzed by Environmental Analysis South, Inc. for TCE. Analysis showed TCE at 21 ppb.

Samples 991491, 991492, 991494, 991495, collected by DNR at staggered intervals of evacuation from the 3496 RR3 residence on January 29, 1999, were analyzed for VOCs only. No VOCs were detected in any of the samples. Samples 500730 (a split of 991491) and 500731 (split of 991494), were collected by DNR and analyzed by Environmental Analysis South, Inc. for TCE. No TCE was detected in either sample. Samples 991412 (a split of 991492) and 991413 (a split of 991494), analyzed by Environmental Health Laboratory, were non detect for all VOCs.

3499 RR3 Well

Samples 991454 and 991455, collected by DNR from the 3499 RR3 residence on January 6, 1999, were analyzed by DNR for total metals (arsenic, barium, cadmium, chromium, copper, mercury, nickel, lead, selenium, silver) and VOCs. In sample 991454, barium was detected at 46.4 ppb, copper was detected at 54.1 ppb, and lead was detected at 4.9 ppb. In sample 991455, barium was detected at 46.7 ppb, copper was detected at 11.5 ppb; lead was not detected. Both samples were non-detect for all VOCs.

As stated previously, the sample collected privately on January 6, 1999, of the 3499 RR3 residence (430114), was analyzed by Environmental Analysis South, Inc. for TCE. Analysis showed TCE at 20 ppb.

Samples 991487, 991488, 991489, 991493, collected by DNR at staggered intervals of evacuation from the 3499 RR3 residence on January 29, 1999, were analyzed for VOCs only. No VOCs were detected in any of the samples. Samples 500728 (a split of 991487) and 500729 (a split of 991488), were collected by DNR and analyzed by Environmental Analysis South, Inc. for TCE. No TCE was detected in either sample. Sample 991411 (a split of 991489), analyzed by Environmental Health Laboratory, was non detect for all VOCs.

Private Well Across from 3496 RR3 on County Road 5-120

Sample 991457, collected by DNR from the residence across the road from 3496 RR3 was analyzed for total metals (arsenic, barium, cadmium, chromium, copper, mercury, nickel, lead, selenium, silver) and VOCs. Barium was detected at 61.2 ppb and copper was detected at 20.2 ppb. The sample was non-detect for all VOCs.

Public Drinking Water Well

Sample 991496, the water grab from the Camden County PWSD #2 Well #1, was analyzed for VOCs. No VOCs were detected.

4.6 Groundwater Conclusions

With the exception of lead, detected in sample 991456 at 17.7 ppb, all metals detected in the private well samples were present at concentrations well below the MCLs. The lead in this groundwater sample is not thought to be related to the Camdenton Sludge Disposal Area site. Analytical results from soil samples collected from the disposal area do not show high levels of leachable lead.

At this time, the discrepancy in results between the samples collected from the 3496 and 3499 RR3 wells when TCE was detected and those when TCE was not detected, is inexplicable. QA/QC data on the two samples analyzed by Environmental Analysis South, Inc., that showed TCE at 20 and 21 ppb, has been reviewed by DNR's Environmental Services Program, and no problems were noted.

Additional sampling is necessary to determine the true nature of the potential contamination of groundwater in the area possibly due to the sludge disposal. Shallow bedrock monitoring wells near the site may help characterize the site conditions.

There are a number of private drinking water wells (at least 87) located within four miles of the site. The concern remains that the sludge deposited may have contained TCE that has infiltrated into the shallow bedrock aquifer. Karst conditions in the area may account for the aberrant nature of TCE detections in the private drinking water wells in the area.

5.0 SURFACE WATER PATHWAY

5.1 Hydrologic Setting

The Camdenton Sludge Disposal Area is situated near the crest of broad ridgetop that acts as the drainage divide between streams draining northwest, toward the Niangua Arm of the Lake of the Ozarks and streams draining east, toward the Dry Auglaize Creek. South and east of the site, unnamed streams flow southeast toward Forbes Branch. The natural landforms and drainage patterns at the site have been obscured by airport construction and soil disposal. The site itself has been leveled, while the surrounding terrain exhibits low natural relief (2% to 4% slopes). Land use patterns for the surrounding upland near

the Camdenton Sludge Disposal Area include residential and agricultural properties with some light-industrial use. The steeper slopes are generally forested (Reference 30).

Surface runoff from the sludge disposal area flows eastward toward Forbes Branch and Dry Auglaize Creek, both losing streams. The intermittent stream near the site flows for one mile before entering the intermittent Forbes Branch, which then flows 1.2 miles before entering the perennially-flowing Dry Auglaize Creek. Because the overland flow distance to the nearest perennial surface water is more than two miles, the surface water pathway is not evaluated for this site (References 3; 30).

5.2 Surface Water Conclusions

The surface water pathway is not evaluated due to an overland flow distance greater than two mile.

6.0 SOIL EXPOSURE AND AIR PATHWAYS

6.1 Physical Conditions

The native soil in the vicinity of the Camdenton Sludge Disposal Area is the Lebanon silt loam. Lebanon soils are deep, moderately well-drained soils typical of ridgetops. Permeability is moderate, although a shallow fragipan, if present, may perch water. Even if a fragipan is present, downward seepage is a potential concern (Reference 30).

The 40 acre site is an open field with grassy vegetation. The only structure on-site is the abandoned machinery used to spread the sludge during land application. There is no visible sludge on the surface. The sludge was reportedly spread, mixed and disced into the native soil (except for several piles in the ditch) and the area was then seeded. Visible sludge was only encountered in two of nine soil borings in the disposal area. It was green in color and definitely distinguishable from the surrounding soil. It was encountered at a 0.5' to 1' depth. Access is not restricted to the site (Reference 5).

6.2 Soil and Air Targets

Residential areas are located immediately west, east and south of the site. Two homes are located on County Road 5-120 within 0.25 of a mile of the site. The residence at 3499 RR3 is within 400 feet of the western edge of the site (Reference 5).

Approximately half of the City of Camdenton lies within four miles of the site (Reference 3). Camdenton has an estimated population of 2,544 people (Reference 35, p. 144). Table 5, on the following page, presents the breakdown of the number of people estimated to be within a four-mile radius of the site (Reference 39).

TABLE 5: ESTIMATED POPULATION WITHIN A 4-MILE RADIUS	
RADIUS	POPULATION
ON-SITE	0
0 - 1/4	4
1/4 - 1/2	46
1/2 - 1	51*
1 - 2	583
2 - 3	428
3 - 4	1,233
TOTAL	2,345
*This value was calculated from a house count of the 1/2 to 1 miles radius ring.	

6.3 Soil and Air Conclusions

All soil samples collected as part of the PA/SI were waste/source samples. Residual sludge material was visible in two samples near the surface (0.5'-1' depth), but the field is well vegetated and is not currently used for any purpose. The risk of exposure to trespassers or passers-by would be minimal. Residential areas are located immediately west, east and south of the site. Two homes are located on County Road 5-120 within 0.25 of a mile of the site. Access to the site is not restricted.

7.0 SUMMARY AND CONCLUSIONS

The Camdenton Sludge Disposal site is located three miles southeast of the City of Camdenton on County Road 5-120, immediately southeast of the Camdenton Memorial Airport. The Camdenton Sludge Disposal Area is the site where sludge from the Hulett Lagoon, one of the City of Camdenton's wastewater lagoons, was deposited in 1989 as part of closure. The actual lagoon is located in the City of Camdenton, over four miles from the sludge disposal site, and is being investigated separately as the Former Hulett Lagoon site. The Former Hulett Lagoon site has documented TCE contamination in the soil and groundwater on-site.

From July 1989 to March 1990, over 2,000 cubic yards of sludge from the Hulett Lagoon were transported to the Camdenton Sludge Disposal Area for land application, as per the approved closure plan. The sludge was spread, mixed and disced into fields a total of approximately 20-40 acres in size. In March 1990, the fields were seeded with a mixture of Timothy and Fescue grasses in order to provide ground cover and prevent erosion. The field has been unused ever since.

Due to the documentation of remaining TCE in the soils at the former lagoon and the highly contaminated groundwater in that area, there was concern that the sludge deposited near the airport may still contain TCE that could be released into groundwater in that area. In August 1998, a sample collected from a private drinking well 500 feet west of the sludge disposal site showed 13.1 ppb TCE. Investigation of the sludge disposal area site was initiated in October 1998.

Waste/Source Sampling

The majority of PA/SI sampling in the sludge disposal area focused on the region near the main drainage ditch, which runs southeast to northwest across the southern portion of the site. It was reported that several loads of sludge were deposited into this ditch near the end of the project without any mixing, discing or spreading. Recognizable sludge material was encountered in two soil borings from the ditch. Levels of chromium, copper, lead and nickel were documented significantly above background in these two samples. Chromium, however, was the only compound detected that was present at a level exceeding the SCDM benchmarks and the MO ASL. TCE was not detected in any of the eight soil samples collected from the disposal area.

Groundwater

One public drinking water supply well and three private drinking water wells were sampled during the PA/SI. No VOCs were detected in the public well. On January 6, 1999 the two closest private drinking water wells to the site were sampled. Samples were collected by DNR for analysis at ESP and additional samples were collected by the home owners for analysis at a private lab. The DNR samples were non-detect for TCE, while the samples from the private lab showed TCE at 20 and 21 ppb. Due to the TCE detection, several additional samples were collected from the wells on January 29, 1999. Fifteen samples were collected, including duplicates and splits, at four different intervals of well evacuation. The samples were analyzed at three separate laboratories. All were non-detect for VOCs. At this time, the reason for the discrepancy in results between the samples collected on January 6 is unknown. Karst conditions in the area may account, in part, for the aberrant nature of TCE detections.

Groundwater use within four miles of the site is extensive. At least 1,888 people are served by public wells in the area and an estimated 210 people are served by private wells. The concern remains that the sludge deposited may have contained TCE that has infiltrated into the shallow bedrock on-site. Additional sampling is necessary to determine the true nature of the potential contamination of groundwater in the area possibly due to the sludge disposal. Shallow bedrock monitoring wells near the site may help characterize the site conditions.

Surface Water

The surface water pathway for this site was not evaluated because the overland flow distance to the nearest perennial surface water is more than two miles.

Soil and Air

All soil samples collected as part of the PA/SI were waste/source samples. Residual sludge material was visible in two samples near the surface (0.5'-1' depth), but the field is not used for any purpose. The risk of exposure to trespassers or passers-by would be minimal. Residential areas are located immediately west, east and south of the site. Two homes are located on County Road 5-120 within 0.25 of a mile of the site. The residence at 3499 RR3 is within 400 feet of the western edge of the site. Access to the site is not restricted.

8.0 RECOMMENDATIONS

Further CERCLA investigation is recommended at this site. Although there were at least ten samples that were non-detect for TCE in the two private drinking water wells, the three TCE detections cannot be dismissed. The karst nature of the geology in the area could account for the aberrant nature of TCE detections. The concern remains that the sludge deposited may have contained TCE that has infiltrated into the shallow bedrock on-site. Groundwater use, both public and private, within four miles of the site is extensive. Additional groundwater sampling is necessary to determine whether TCE is present in the bedrock beneath the site. Shallow bedrock monitoring wells near the site may help characterize the site conditions.

Camdenton Sludge Disposal Area
Combined PA/SI
March 30, 1999

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Figure 1: Site Location Map
Camdenton Sludge Disposal Area Site
Camden County, MO

APPENDIX A
FIGURES

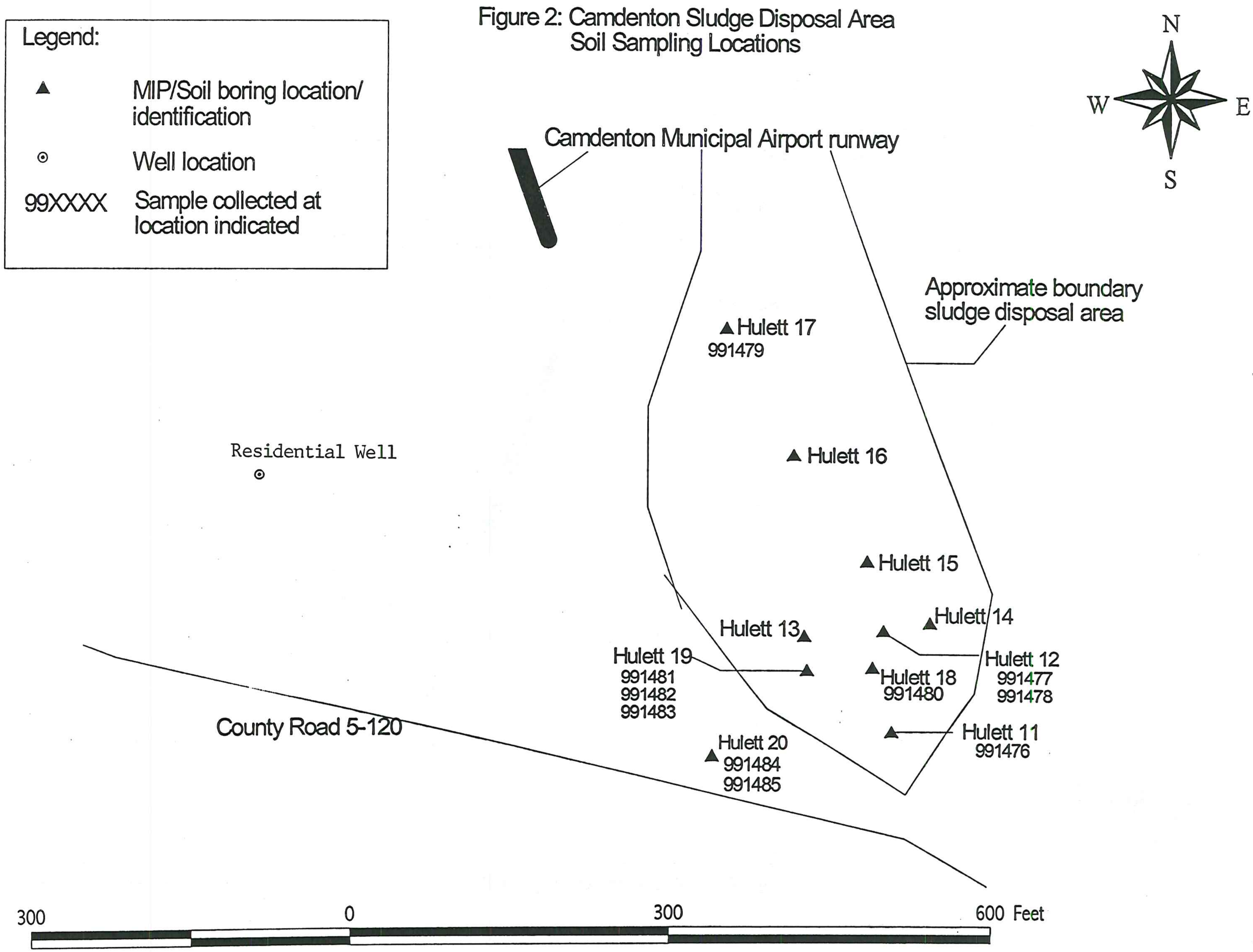


Figure 2: Camdenton Sludge Disposal Area
Soil Sampling Locations

Figure 3: Camdenton Sludge Disposal Area
Well Sampling Locations

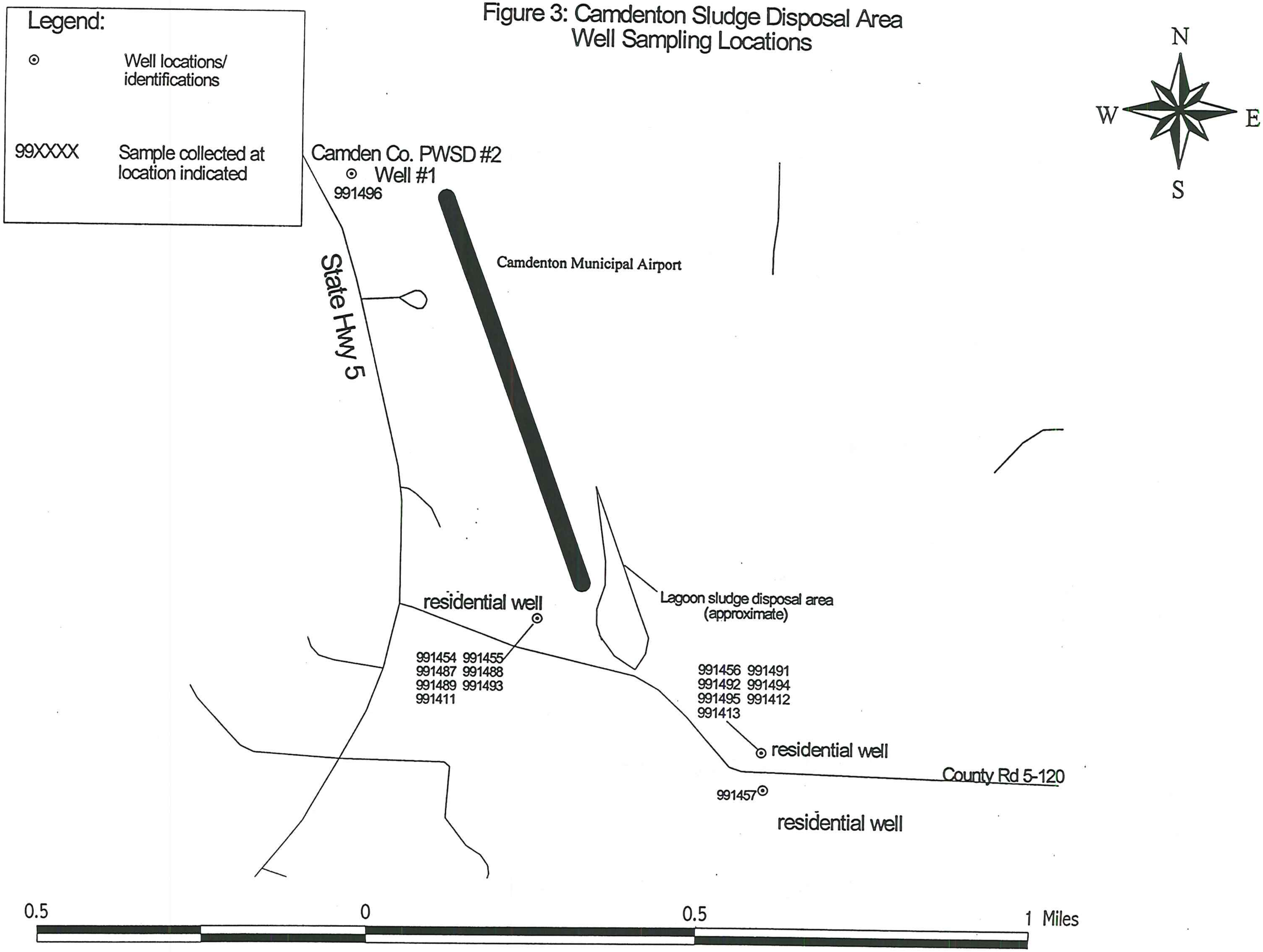
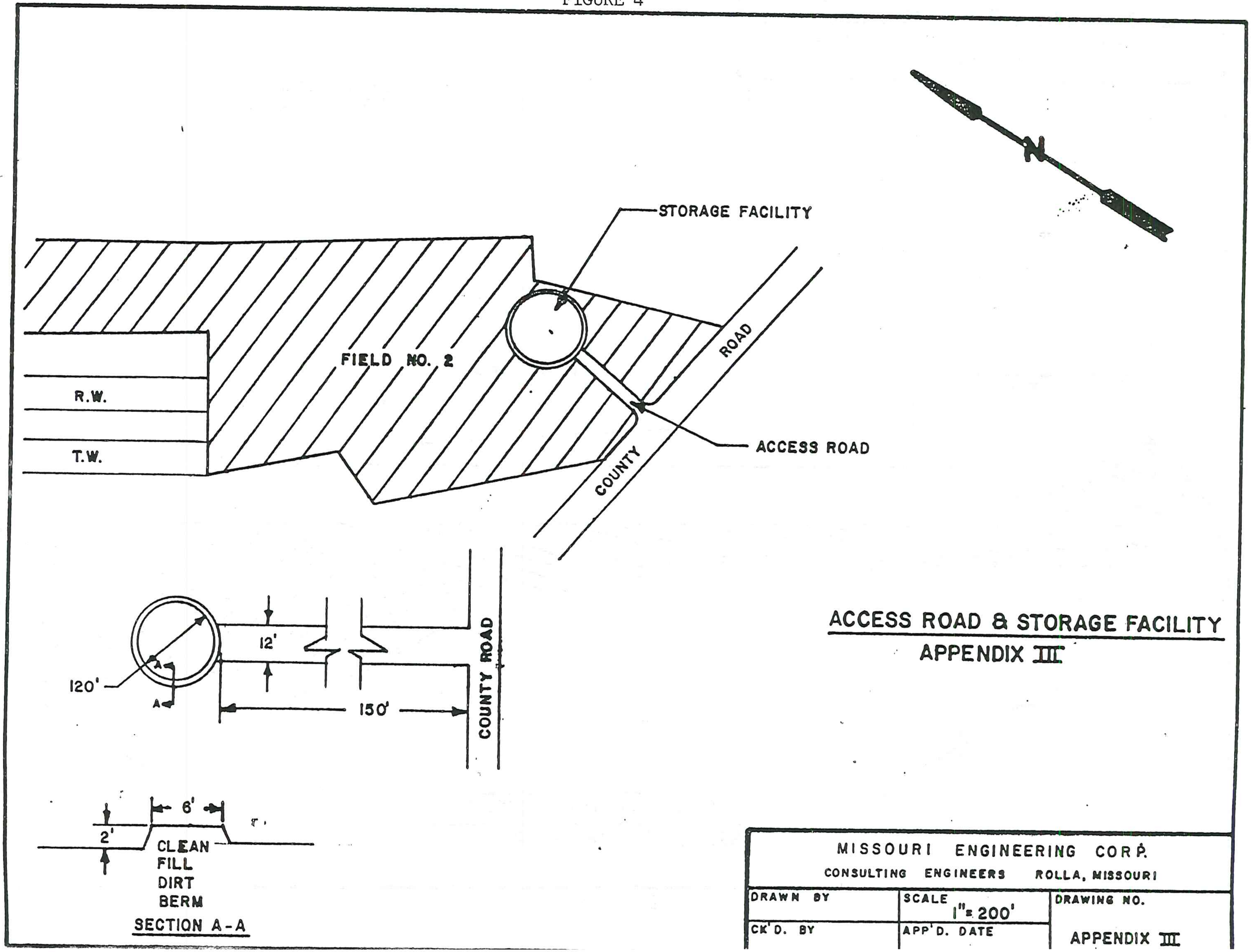


FIGURE 4



STORAGE FACILITY
FIELD NO. 2
R.W.
T.W.
ROAD
COUNTY
ACCESS ROAD
12'
120'
A
A
150'
COUNTY ROAD
6'
2'
CLEAN FILL DIRT BERM
SECTION A-A
ACCESS ROAD & STORAGE FACILITY
APPENDIX III
MISSOURI ENGINEERING CORP.
CONSULTING ENGINEERS ROLLA, MISSOURI
DRAWN BY
SCALE 1" = 200'
DRAWING NO.
CK'D. BY
APP'D. DATE
APPENDIX III

FIGURE 5

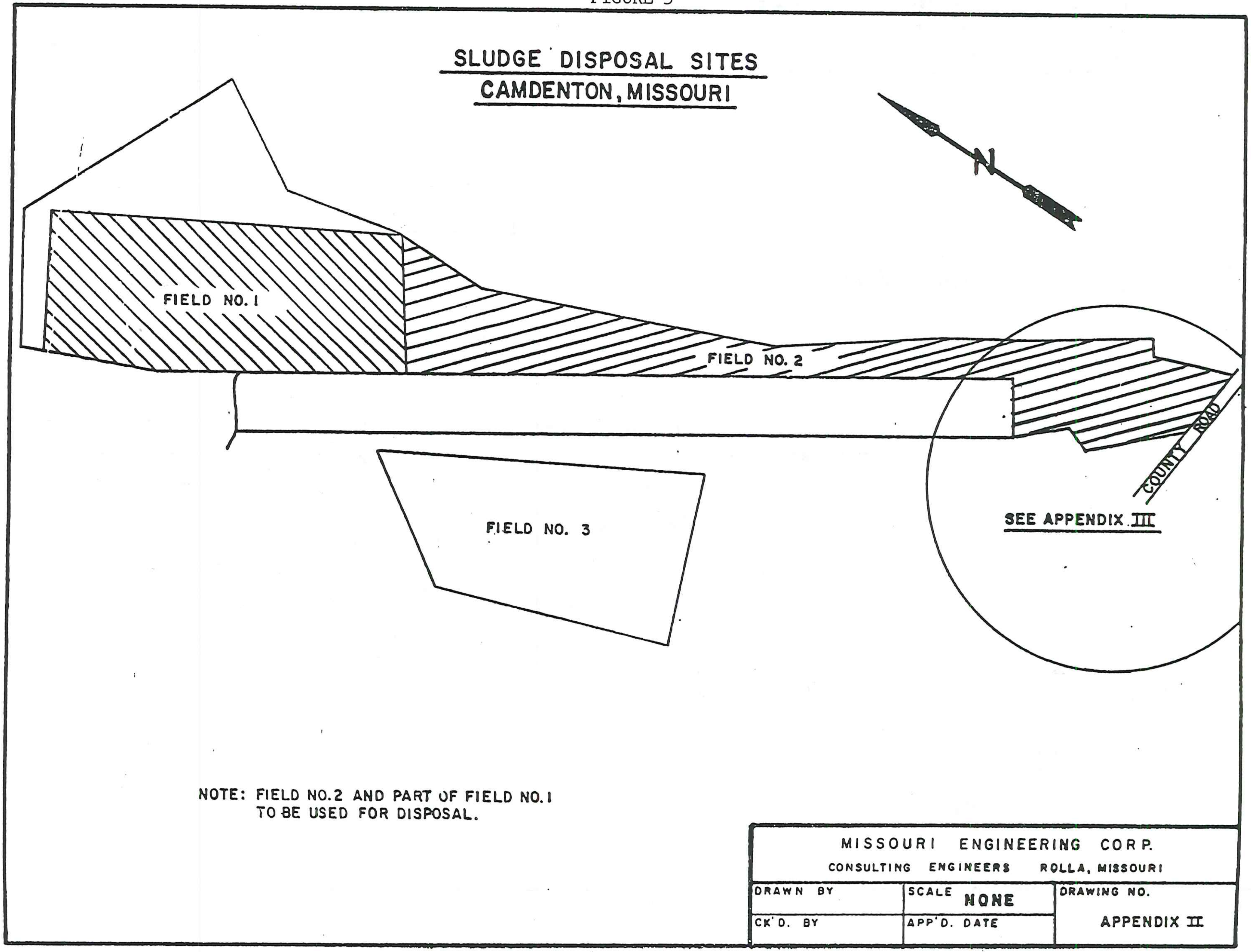

SLUDGE DISPOSAL SITES
CAMDENTON, MISSOURI
N
FIELD NO. 1
FIELD NO. 2
FIELD NO. 3
COUNTY ROAD
SEE APPENDIX III
NOTE: FIELD NO.2 AND PART OF FIELD NO.1 TO BE USED FOR DISPOSAL.
MISSOURI ENGINEERING CORP.
CONSULTING ENGINEERS ROLLA, MISSOURI
DRAWN BY
SCALE NONE
DRAWING NO.
CK'D. BY
APP'D. DATE
APPENDIX II

PHOTO 1

Former Hulett Lagoon Site. Camdenton, MO, Camden County. Photo taken on 10/1/74 by Ronnie Testerman, MDNR, JCRO. View looking northeast at the Hulett lagoon during operation. The northern portion of the lagoon shown in the photo was where influent from domestic sewage entered the lagoon. A small amount of the sludge from the Sundstrand influent, which came in on the south portion of the lagoon can be seen in the foreground of the photo near the wooden catwalk.

PHOTO 2

Former Hulett Lagoon Site. Camdenton, MO, Camden County. Photo taken on 10/1/74 by Ronnie Testerman, MDNR, JCRO. View looking east at the Hulett lagoon during operation. The picture was taken to show the sludge settling around the influent pipe area from Sundstrand.

PHOTO 3

Former Hulett Lagoon Site. Camdenton, MO, Camden County. Photo taken sometime in June or July 1989 by Ronnie Testerman, MDNR, JCRO. View looking northeast at the Hulett lagoon during the beginning of the closure process. The dewatering had begun, but no sludge had been removed.

Mel Carnahan, Governor • Stephen M. Mahfood, Director

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL QUALITY
P.O. Box 176 Jefferson City, MO 65102-0176

MEMORANDUM

DATE: February 1, 1999

TO: Former Hulett Lagoon and Camdenton Sludge Disposal Technical Files

FROM: Valerie H. Wilder, Environmental Specialist VW
Site Evaluation Unit, Superfund Section
Hazardous Waste Program

SUBJECT: Site Visits/Sampling Events on
December 1, 16, 1998 and January 21-22, 29, 1999

December 1, 1998, Site Visits

On December 1, 1998, I traveled to Camdenton, Missouri, to review city files on the former Hulett Lagoon. I went to City Hall and spoke with the ~~mayor~~ City Administrator VW, Mr. Elmer Meyer. I made copies of the pertinent information on the operation and closure of the Hulett Lagoon. Mr. Tom Emry, Camdenton's Sewer Treatment Plant Manager, stopped by the city hall to answer some of my questions and help interpret maps. After reviewing the files, Mr. Vince Costa, Public Works Director, drove me around and showed me the former Hulett Lagoon, the sludge disposal area out near the airport, and all of the city's drinking water wells.

Directions to the Former Hulett Lagoon site: from the intersection of U.S. Highway 54 and State Route 5 in Camdenton, take State Route 5 northwest for 0.3 of a mile to East Mulberry; take a left onto East Mulberry and the first right onto West Mulberry. When the paved portion of West Mulberry curves to the left, continue straight onto a gravel driveway that leads behind the Ron Hulett Chevrolet-Olds-Buick Jeep/Eagle automobile dealership. Stay to the left on a gravel road that leads down to the lagoon. This road is not regularly maintained; there are several severe ruts caused from washouts.

The lagoon was named and most commonly referred to as the Hulett Lagoon, apparently due to its proximity to the Ron Hulett automobile dealership that is located at 249 N. Highway 5. The former Hulett Lagoon is currently an open field area with grassy vegetation. Remnants of the former berm and the road that surrounded the lagoon are still visible. The lagoon area is generally flat, with surface runoff flowing to the northwest and entering an intermittent drainage that travels to the west. There is a

monitoring well, installed by Modine Manufacturing's consultant, located just outside what would have been the southwest edge of the berm of the lagoon. This is known as MW-5. During the closure of the lagoon, apparently, no soil was brought in for the mixing. Some soil from the hillside southeast of the lagoon was scraped in to fill the void.

The lagoon is located in a mixed residential/commercial area of Camdenton. It is bordered on the north by an apartment complex; on the west by a strip of woods about 500 feet wide with Dawson Road on the other side; on the east by woods; and on the south by a strip of woods and then residences. At least two of the apartment buildings in the complex north of the site are within 200 feet of the site, as well as the apartment building and one home south of the site. Access to the lagoon area is not restricted. There is no fencing or gates.

Directions to the Camdenton Sludge Disposal Area site: from the intersection of U.S. Highway 54 and State Route 5 in Camdenton, take State Route 5 southeast for 4.4 miles to County Road 5-120; take a left onto CR 5-120, a gravel road, and travel east. The disposal area is 0.3 of a mile down the road on the north side.

The outline of the stockpiling area is faintly discernable today. The spreader used during the sludge disposal operation was left on-site and is situated approximately 100 yards northwest of the stockpiling area. There are no other structures in the area. Most drainage for the site flows into a low ditch that runs west to east across the southern portion of the site.

The sludge disposal area is bordered on the south by County Road 5-120; on the north by the Camdenton Memorial Airport; on the west by a residence; and on the east by a wooded area. The residence at 3499 RR3 is within 400 feet of the western edge of the site. Access to the site is not restricted. There is no fencing or gates

<u>December 16, 1998, Site Visits</u>
On December 16, 1998, Brian Allen, of the Environmental Services Program, and I traveled to Camdenton to visit the two sites and begin planning for the Combined PA/SI sampling events that were scheduled for January 1999. We met [redacted], a city employee at the Sewer Treatment Plant, at the sludge disposal site near the airport. [redacted] lives just down County Road 5-120 from the sludge disposal site. [redacted] told us about the sludge disposal operations that occurred during the closure of the Hulett Lagoon in 1989 and 1990. Since [redacted] lived just down the road, he saw activity at the sludge disposal area almost daily. He said that the sludge was more difficult to spread evenly than the contractors originally anticipated. It didn't

dry out completely and would stick together in clumps. Near the end of the process, he said the contractor took the last several piles of sludge material and simply dumped them into the ditch located about 50 feet north of the circular storage area. It was not spread, mixed or disced.

The following information regarding the sampling events are details that are not documented in the Environmental Services Program Sampling Reports.

<u>January 21, 1999, Sampling Event</u>
Sampling at the Hulett Lagoon commenced on January 21, 1999. That day, Ron Hulett car dealership personnel reported that people often dump trash and junk in the wooded area behind their facility that borders the road leading down to the lagoon. There were also a few pieces of trash in the lagoon area.

<u>January 22, 1999, Sampling Event</u>
Sampling at the Camdenton Sludge Disposal Area site commenced on January 22, 1999. Green sludge material was encountered in borings Hulett 12 and Hulett 19, from the ditch area.

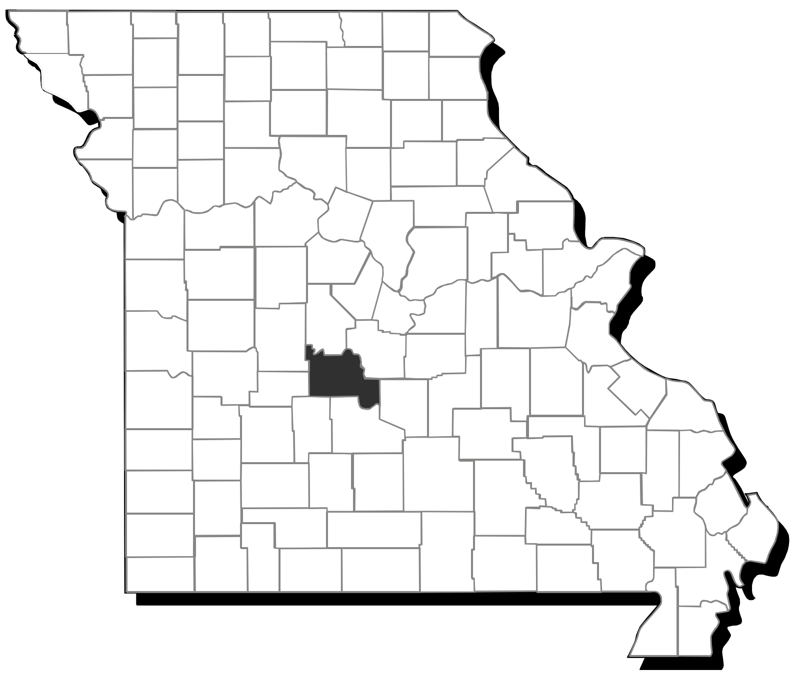
<u>January 29, 1999, Sampling Event</u>
Camden County PWSD #2 personnel reported that Well #2 is the primary well that supplies 99 percent of the water for the district.

VHW:ln

COMBINED PRELIMINARY ASSESSMENT/SITE INSPECTION REPORT

Former Hulett Lagoon Site
Camdenton, Missouri

March 30, 1999



Missouri Department of Natural Resources
Division of Environmental Quality
Hazardous Waste Program

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DATE: March 30, 1999

PREPARED BY: Valerie H. Wilder
Missouri Department of Natural Resources

SITE: Former Hulett Lagoon
Camden County

C.A. NUMBER: V997381-98-0

EPA ID. NUMBER: N/A

1.0 INTRODUCTION

Under the authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Missouri Department of Natural Resources (DNR), through a cooperative agreement with the U.S. Environmental Protection Agency (EPA), conducted a combined Preliminary Assessment/Site Inspection (PA/SI) at the Former Hulett Lagoon site in Camden County, Missouri. The purpose of this investigation was to collect sufficient information concerning conditions at the site to assess the threat posed to human health and the environment, to determine the need for additional investigation under CERCLA/SARA or other authority, and if appropriate, support ranking the site using the Hazard Ranking System (HRS) for proposal to the National Priorities List (NPL). The scope of the investigation included review of previous file information, sampling of waste and environmental media to evaluate and document HRS factors, and collecting additional non-sampling information. Investigations included site visits on December 1, 16, 1998 and site sampling on January 6-7, 21,1999. The PA/SI was initiated on October 27, 1998.

2.0 SITE DESCRIPTION

2.1 Location

The Former Hulett Lagoon site is the location of a closed wastewater lagoon. The lagoon is located in the City of Camdenton, 500 feet northeast of the intersection of Dawson Road and Sunset Drive (Reference 3). Geographic coordinates for the site are 38°00'41.1" north latitude and 92°45'17.0" west longitude, as measured using the Garmin 12LX Global Positioning System (Reference 4). The lagoon is in the Southwest Quarter (SW 1/4) of the Southwest Quarter (SW 1/4) of the Southwest Quarter (SW 1/4) of Section 24, Township 38 North, Range 17 West in Camden County. Figure 1 is a site location map (Reference (Reference 3).

The site can be accessed from the intersection of U.S. Highway 54 and State Route 5 in Camdenton by taking State Route 5 northwest for 0.3 of a mile to East Mulberry; take a left onto East Mulberry and the first right onto West Mulberry. When the paved portion of West Mulberry curves to the left, continue straight onto a gravel driveway that leads behind the Ron Hulett Chev-Olds-Buick Jeep/Eagle Automobile Dealership. Stay to the left on a gravel road that leads down to the lagoon. This road is not regularly maintained; there are several severe ruts caused from washouts (Reference 5).

The Camdenton area receives an average of 42.32 inches of precipitation annually, and an average of 19 inches of snowfall annually (Reference 6, p. 2). The 2-year 24-hour rainfall estimated at 3.5 inches (Reference 7). The average daily temperature during the summer months is 77° F, and the average winter temperature is 35° F (Reference 6, p. 2). The average wind speed and direction is approximately 10 miles per hour from the south (Reference 8, p. 74).

2.2 Site Description

The former Hulett lagoon is a closed wastewater sewage lagoon operated by the City of Camdenton from 1961 to 1988. The lagoon was approximately one acre in size (Reference 9, p. 12). Photos 1 and 2 were taken in October 1974 when the lagoon was operating. Photo 1 shows the north side of the lagoon where an influent pipe from a city sewer line entered the lagoon. Photo 2 shows the south side of the lagoon where an influent pipe from an industrial facility entered the lagoon. The wooden catwalk, also shown in photo 2, extended into the lagoon and supported the outlet pipe, which ran under the catwalk, and could be raised and lowered with a crank handle (the red apparatus on the end of the catwalk railing). More detailed operating conditions are discussed in the next section. A dirt road ran along the berm and surrounded the lagoon, as shown in photos 1 and 2.

In 1989, the lagoon was closed; the water was drained and the sludge was removed (Reference 9, p. 12). Photo 3 was taken during the dewatering process. The site is currently an open field area with grassy vegetation (Photos 4, 6-8). Remnants of the former berm and the road that surrounded the lagoon are still visible. The lagoon area is generally flat with surface runoff flowing to the northwest and entering an intermittent drainage that travels to the west. There is a monitoring well (MW), installed in July 1998, located just outside what would have been the southwest edge of the berm of the lagoon. This is known as MW-5 (Reference 5).

The lagoon is located in a mixed residential/commercial area of Camdenton. It is bordered on the north by an apartment complex (Photo 8); on the west by a strip of woods about 500 feet wide with Dawson Road on the other side; on the east by woods (Photo 7); and on the south by a strip of woods (Photo 6) and then residents. Access to the lagoon area is not restricted. There is no fencing or gates. The Ron Hulett car dealership personnel have

reported unauthorized dumping in the wooded area behind their facility that borders the

road leading down to the lagoon (Reference 5).

2.3 Operational History

General Overview of Hulett Lagoon

The City of Camdenton, Missouri has owned the former Hulett lagoon property since at least 1961 and retains ownership today. The lagoon was constructed in 1961 under the State of Missouri Grants Program. The lagoon was constructed of clay, and its berms were approximately 25 feet wide and 15 feet high (Reference 9, p. 12). The lagoon was named and most commonly referred to as the Hulett Lagoon due to its proximity to the Ron Hulett automobile dealership that is located at 249 N. Highway 5 (Reference 5). The lagoon was also referred to as the Factory Lagoon and Camdenton Lagoon #3 (Reference 10).

The Hulett lagoon was in operation from 1961 until its closure in late 1989. It was one of five municipal lagoons that serviced the City of Camdenton, however, it was the only lagoon that received industrial effluent in addition to domestic sewage. From 1967 through 1986 a nearby manufacturing facility released untreated wastewater and storm water into the lagoon through a series of "mudpits", or sumps, via a storm sewer. In 1986, the facility installed a pretreatment wastewater system that replaced the mudpits and lagoon system (References 9, p. 12; 11, p. 1).

The facility is located approximately 1,000 feet southeast of the lagoon at 179 Sunset Drive. Heat transfer components for commercial and automotive industries are manufactured at the facility. The untreated wastewater was known to have contained several hazardous waste streams including corrosive waste, wastewater treatment sludges from electroplating operations, and waste oil. In addition, residual contaminants associated with degreasing operations, including TCE, was discharged into the mud pits and ultimately into the Hulett lagoon (References 9, p. 12; 11, p. 1; 16, p. 8).

Ownership History of Facility at 179 Sunset Drive

The 179 Sunset Drive property was originally held by Dawson Metal Products, Inc., a Kansas Corporation ("Dawson-Kansas"), pursuant to a lease dated November 28, 1966 between Dawson-Kansas and the Camdenton Industrial Development Corporation. The lease had a term of ten years, which is believed to have commenced July 1, 1967, with an option for Dawson-Kansas to purchase (Reference 12, p. 3).

On June 12, 1972, Dawson Metal Products, Inc. was issued a Certificate of Incorporation in the State of Delaware (Reference 13). In 1972 Sundstrand Corporation incorporated Dawson Metal Products, Inc., a Delaware Corporation ("Dawson-Delaware"), as a wholly owned subsidiary of Sundstrand Corporation. On June 29, 1972, Dawson-Delaware acquired the business and assets of Dawson-Kansas. In connection with the acquisition Dawson-Delaware, by way of assignment, acquired a leasehold interest in the 179 Sunset Drive property (Reference 12, p. 3). On September 25, 1972, Dawson Metal Products, Inc. (the Delaware Corporation) was authorized as a Foreign Corporation in the State of Missouri to carry on the business of sale and distribution of air conditioning equipment and

related parts (Reference 14).

On May 25, 1977 Dawson Metal Products, Inc. (the Delaware Corporation) changed its corporate name in the State of Missouri to Sundstrand Tubular Products, Inc. (Reference 15).

On August 24, 1990, Sundstrand agreed to sell the business and assets of Sundstrand Tubular Products, Inc. to Modine Heat Transfer, Inc., a wholly owned subsidiary of Modine Manufacturing Company, a Wisconsin based corporation that operates and conducts business in the state of Missouri. This transaction was closed on October 18, 1990 (References 16, pp. 3, 4; 12, p. 3).

On November 27, 1990, Sundstrand Tubular Products, Inc. changed its name to Sundstrand Camdenton, Inc (Reference 12, p. 3). On April 18, 1991, Sundstrand Tubular Products, Inc., a Foreign Corporation, was formally withdrawn from the State of Missouri (Reference 17). On March 15, 1994 Sundstrand Camdenton, Inc. was liquidated (Reference 12, p. 3).

On April 1, 1997, Modine Heat Transfer, Inc. merged with Modine Manufacturing Company; thus, changing its name to Modine Manufacturing Company. Modine is the current owner/operator of the facility (Reference 16, pp. 3, 4).

Operational History of 179 Sunset Drive Facility

The facility at 179 Sunset Drive has always been used to manufacture air-conditioning coils and feeder parts from aluminum and copper tubing. According to Sundstrand personnel, the manufacturing process flowed as follows:

- copper and aluminum tubing were fed from rolls to benders to form U shapes and then cut off;
- parts were then immersed in alkaline cleaning lines to remove oil and chips;
- parts were degreased to remove any remaining oil;
- clean parts were assembled and small U shaped copper tubing and aluminum tubing ends were brazed to assembled cores using manual and automatic brazing systems;
- the assembled heat transfer components were degreased and/or alkaline cleaned and then tightness tested using refrigerant; and
- finally, the components were then painted if required by the customer and packaged for shipment (Reference 12, p. 4)

The manufacturing process consisted of aluminum etching, and a small amount of chromium electroplating (Reference 11, p. 2). According to an Environmental Site Assessment conducted in November 1991 for Modine Manufacturing Company, the facility generated TCE waste during degreasing operations from the early 1970's to December 1990. In December 1990, they began using 1,1,1-trichloroethane (TCA) for degreasing

operations (Reference 18, p. 1).

Four mudpits (sumps) were utilized by the facility from 1967 to 1986. The mudpits were connected by a six-inch steel line that delivered storm water (from 1979 to 1983, eliminated in 1983), boiler water and cleaning line waste to the Hulett lagoon. The mudpits were located adjacent to the manufacturing building on the west side. Each mudpit consisted of a 4' x 4' x 4' cement sump. Each sump received the previous sumps' wastes until discharged into the sewer. The southern most mudpit, #4, was an open pit that collected boiler water and storm water. Mudpit #3 collected aluminum cleaning line waste and storm water from mudpit #4. Mudpit #1 collected copper cleaning line waste in addition to aluminum cleaning line waste and storm water from the first two mudpits. Hulett lagoon potentially received hazardous waste from the facility's four mudpits and associated piping, identified by the following hazardous waste codes: F006 (wastewater treatment sludges from electroplating), D002 (corrosive waste) and D098 (waste oil). In addition, residual contaminants associated with degreasing operations, including TCE, did go through collection lines into the mud pits and ultimately into the Hulett lagoon (References 9, p. 13; 16, p. 8).

Operational History/Regulatory Compliance of Hulett Lagoon

The Hulett Lagoon operated with a National Pollutant Discharge Elimination System (NPDES) Permit (MO-0048577) issued under the Clean Water Act by the DNR's Water Pollution Control Program (WPCP) (Reference 10). The WPCP database shows the permit issued July 1985, although it is likely the permit was actually issued earlier. The permit was terminated February 29, 1988.

DNR Inspection - September 7, 1978

In September 1978, DNR personnel conducted an inspection of the operation and condition of the wastewater treatment facilities serving the City of Camdenton. The inspector noted that the Hulett Lagoon had a large problem with its industrial influent. The sewage from Sundstrand was entering the lagoon at the south end, which was the same end that the lagoon's discharge pipe was located. The retention time for the industrial waste was far too short a period to treat the waste. To correct the problem, it was recommended that the location of the influent pipe from Sundstrand be moved to the north end of the lagoon, or the sewage line be tied in to the other influent line already at the north end. The inspector also noted that the strength of the Sundstrand industrial sewage entering the Hulett Lagoon was apparently too great for the facility to handle. It was recommended to the city that they enforce their sewer use ordinance to prevent misuse of the sewers and sewage treatment facilities (Reference 19).

DNR Geologic Investigation - September 12, 1978

On September 12, 1978 DNR personnel from the Division of Geology and Land Survey (DGLS) conducted an investigation for an Engineering Geologic Report on the Collapse Potential of Camdenton Lagoons. The inspector noted that the problems at the Hulett

lagoon appeared to be design related and not geologic. Like the previous inspectors, DGLS personnel noted the short circuiting problem. They observed effluent from the metal fabricating plant bubbling up approximately 40 feet from the discharge pipe. There was an area of thick floating effluent. An open channel existed directly from the inlet pipe to the discharge pipe. Discharge from the lagoon was dark green in color with thick white foam floating on the surface (similar to that in Photo 2) (Reference 20).

<u>Lagoon Sampling in 1984</u>
On May 22, 1984 the City of Camdenton collected samples of the Hulett lagoon water, Sundstrand's influent to the lagoon, housing influent to the lagoon, effluent from the lagoon, and water near Lake of the Ozarks. Results showed 41 parts per billion (ppb) TCE in the Sundstrand influent and 28 ppb TCE in the effluent from the lagoon (Reference 21).

On July 19, 1984 additional samples of Sundstrand's effluent and lagoon water were collected. This Sundstrand effluent sample showed 4,900 ppb TCE in addition to 7,600 ppb, total chromium, 29,000 ppb total copper, and 1,400 ppb total zinc. The sample from the lagoon showed 500 ppb TCE, 500 pbb total chromium, 200 ppb hexavalent chromium, 4100 ppb total copper and 230 ppb total zinc (Reference 22).

<u>Construction of Sundstrand's Pretreament Plant in 1986</u>
Sundstrand and the City of Camdenton joined efforts in 1986 to obtain a Community Development Betterment Grant (CDBG) from the state to construct a pretreatment plant at the Sundstrand facility. The plant was completed and on line as of April 14, 1986. The plant still operates today (Reference 23).

<u>Construction Permit for Lagoon to Replace Hulett Lagoon</u>
On September 23, 1986, DNR issued the City of Camdenton a Construction Permit for sewers, force mains and lift stations for transport of waste to the C.P. White Lagoon. The construction permit stated that these facilities were designed to allow for elimination of the existing factory lagoon (Hulett Lagoon) (Reference 24).

<u>Pretreatment Monitoring Report - April 30, 1987</u>
At the request of DNR's WPCP, a pretreatment monitoring survey was conducted of the industrial wastewater discharge of the Sundstrand Tubular Products factory. On April 30, 1987, DNR's Environmental Services Program (ESP) collected a grab sample of the effluent from the treatment system discharge weir. The sample was analyzed for cyanide, total metals (silver, cadmium, chromium, copper, hexavalent chromium, nickel, lead, zinc). The sample was also supposed to be analyzed for volatile organic compounds (VOCs), however, there were no results for VOCs due to analytical error. Results showed

chromium at 2,700 ppb, copper at 890 ppb, hexavalent chromium at 180 ppb, nickel at 50 ppb, and zinc at 110 ppb (Reference 25).

<u>Hulett Lagoon Closure</u>
In 1988, the City of Camdenton began closure of the Hulett Lagoon pursuant to an

Industrial Development Grant overseen by DNR's WPCP. As per DNR guidelines for closing out municipal lagoons, sampling and analysis of the sludge in the lagoon was limited to metals and other parameters such as total solids. High levels of chromium, lead, and nickel were detected (Reference 26). DNR offered the City officials several options to consider in completing the closure of the lagoon (Reference 27). The option chosen and implemented by the city was subsurface application of the sludge from the lagoon to a sludge disposal site owned by the city. DNR approved the sludge disposal plan on February 22, 1989 (Reference 28).

The city's engineering consultant, Missouri Engineering Corporation, supervised the lagoon closure project. In June 1989, McCormick Gravel & Excavating of Versailles, Missouri was awarded the contract for the removal, stockpiling and disposal of sludge from the lagoon. The contract included lagoon dewatering, preparation, transportation, and stockpiling of the sludge, as well as disposal by land application at chosen site at the Camdenton Memorial Airport (CMA), four miles southeast of Camdenton (References 29; 30).

The specifications called for the contractor to pump the water from the lagoon and discharge it into the existing sewer manhole approximately 100 feet away (Reference 29). The process of removing the sludge at the lagoon began on July 11, 1989 and was completed sometime in late September 1989. Lime was added to the sludge at the lagoon to raise the pH and immobilize the metals. The project contract was originally written with an estimate of 1,500 cubic yards of sludge to be removed. However, due in part to an unusually high amount of rain during the removal process, the sludge did not dry out and shrink, as it should have. In addition, each time it would rain, the rain would cause the sludge to be spread across the lagoon contaminating more soil. The lagoon had to be pumped again and the sludge allowed to dry. A small amount of soil then had to be removed along with the sludge. When that portion of the project was completed, an estimated 2,395 cubic yards of sludge had been removed (References 31; 32; 33). The berms of the lagoon were turned in and mixed with a 1 to 1 ratio (Reference 34). No soil was brought in for the mixing. Some soil from the hillside southeast of the lagoon was scraped in to fill the void (Reference 5).

The sludge was deposited at the CMA from July through December 1989. The area at the CMA where the sludge was disposed of is being investigated as a separate site - the Camdenton Sludge Disposal Area. A Combined Preliminary Assessment/Site Inspection is being conducted at the site, and will be completed by April 1999.

2.4 Site History and Previous Investigations

<u>Preliminary Assessment/Site Inspection at 179 Sunset Drive Facility</u>
In 1992, DNR conducted a PA and an SI of the facility at 179 Sunset Drive under the name Sundstrand site (MOD062439351). The investigations were initiated due to a complaint filed with DNR alleging that 4,500 gallons of TCE had been spilled at the facility. Neither

the PA nor the SI included any off-site investigations of the former lagoon or sludge disposal area (References 35; 36).

In addition to the PA and SI conducted by DNR, there were several other investigations conducted at the Modine facility during that time period by EPA contractors and Modine consultants. In general, all of the investigations documented and/or confirmed the presence of chlorinated solvents, including TCE, in the soils and groundwater at the facility. At that time, the DNR determined that oversight authority of the facility was most appropriate under the Resource Conservation and Recovery Act (RCRA).

<u>RCRA Corrective Action at 179 Sunset Drive Facility</u>
Modine Manufacturing Company is currently negotiating a Corrective Action Abatement Order on Consent (AOC) through the Permits Section of DNR's Hazardous Waste Program (HWP). The objectives of the AOC include investigation to determine the nature and extent of any release of hazardous waste at the facility and to remediate any releases in order to protect human health and the environment (Reference 16). There have already been several investigations and a certain amount of remedial activities conducted by Modine at the facility and in the surrounding area. Detailed information regarding a subsurface investigation conducted at the Hulett lagoon in 1996 is included in Section 3.1 Previous Waste/Source Sampling. More information regarding groundwater sampling conducted in the area is included in Section 4.2 Previous Groundwater Sampling.

<u>Referral of Former Hulett Lagoon to Superfund Section</u>
On September 8, 1998 the Permits Section of the HWP formally referred investigation of the former Hulett Lagoon to the Superfund Section of the HWP. Investigation of the Hulett Lagoon is not included in the AOC with Modine due to the fact that, in addition to receiving wastewater from the facility at 179 Sunset Drive, the lagoon also received domestic sewage from the surrounding residences. A dye trace study of the City of Camdenton's sewer system performed by DNR's DGLS on August 5, 1998, verified that facility wastewater mixes with domestic sewage prior to entering city property (Reference 37).

According to 40 CFR 261.4(a)(1), domestic sewage and any mixture of domestic sewage and other wastes that pass through a sewer system to a publicly owned treatment works (POTW) are not considered solid wastes, and thus would not be considered hazardous wastes. The facility that disposes of such wastes is excluded from RCRA permitting requirements, which is why the Hulett Lagoon site was referred to Superfund to be addressed under CERCLA. CERCLA has no such exemption.

2.5 Waste Characteristics

The primary contaminant of concern at the Former Hulett Lagoon site is the volatile organic compound (VOC) trichloroethene (TCE). Analytical results from soil and groundwater sampling show TCE at concentrations above Superfund Chemical Data Matrix (SCDM) health-based benchmarks as well as the Maximum Contaminant Level (MCL) for drinking water (Reference 38).

Trichloroethene

TCE is a nonflammable, colorless liquid at room temperature with a somewhat sweet odor and sweet, burning taste. The manmade chemical does not occur naturally in the environment. TCE is now mainly used as a solvent to remove grease from metal parts. It is also used as a solvent in other ways and is used to make other chemicals. TCE evaporates easily into the air but can persist in the soil and groundwater. Once TCE is in surface water, much of it will evaporate into the air. It will take days to weeks to break down in surface water; in groundwater, the breakdown is much slower because of the slower evaporation rate. Very little TCE breaks down in the soil, and it can pass through the soil into underground water (Reference 39, pp. 1, 2).

TCE can enter the body from breathing air or drinking water containing TCE. It can also enter through the skin, but not as easily as by breathing or drinking. If the chemical is inhaled, about half will enter the bloodstream and organs; the remaining is exhaled. If TCE is swallowed, most will be absorbed into the blood. The liver changes most of the TCE to other chemicals and the majority of these breakdown products leave the body in the urine within a day. Some of the common symptoms to TCE exposure (usually at high levels) are headaches, dizziness, and rashes. Laboratory animals that were exposed to moderate levels of TCE had enlarged livers, and high-level exposure caused liver and kidney damage. However, it is not known if these changes would occur in humans. TCE is considered an animal carcinogen (Reference 39, pp. 1-4).

TCE is known as a Dense Nonaqueous Phase Liquid (DNAPL). DNAPLs are separate-phase hydrocarbon liquids that are denser than water. DNAPLs can exist in the soil/aquifer matrix in free-phase form or in residual form. When released on the ground's surface, free-phase DNAPLs move downward through the soil matrix under the force of gravity or laterally along the surface of sloping fine-grained stratigraphic units. As free-phase DNAPLs move, residual amounts are trapped in pores and/or fractures by capillary forces. Trapped DNAPLs are known as residual saturation. This residual saturation is a function of the physical property of the DNAPL and the hydrogeologic characteristics of the soil/aquifer medium, which typically ranges from 5-50% of total pore volume (Reference 40).

Most DNAPLs undergo only limited degradation in the subsurface and persist for long periods of time, while slowly releasing soluble organic constituents to groundwater through dissolution. Dissolution may continue for hundreds of years under natural conditions before the DNAPL is dissipated (Reference 40).

3.0 WASTE/SOURCE SAMPLING

3.1 Previous Sampling (Reference 41)

On October 11, 1996, on behalf of Modine Manufacturing Company, Dames & Moore

conducted a subsurface investigation at the former Hulett lagoon. The purpose of the investigation was to determine the presence or absence of VOCs, in particular TCE, in soil at the former Hulett lagoon.

Four hydraulically driven probes were advanced in the area of the lagoon where the inlet pipe from the former Sundstrand facility and the outlet or discharge pipe from the lagoon were previously located. The soil within the probe cores was continuously sampled and field screened using a photoionization detector (PID). The soil sample exhibiting the highest indication of VOC content from each probe core was submitted for analysis. The samples were analyzed for VOCs only. The following table presents results for those samples.

TABLE 1: SELECTED ANALYTICAL RESULTS FROM SOIL SAMPLES COLLECTED BY DAMES & MOORE IN HULETT LAGOON ON OCTOBER 11, 1996

Sample ID	Depth	Analyte Detected	Concentration (in ppm)
GP-1	4' - 6'	chloroform	0.20
		TCE	9.17
GP-2	4' - 5.5'	TCE	1.94
GP-3	4' - 5'	chloroform	0.0094
		cis-1,2-dichloroethene	0.0914
		TCE	not detected
GP-4	4' - 6'	TCE	not detected

Although the majority of sludge from the lagoon was supposedly removed during closure, these sampling results indicated that TCE contamination was still present in the lagoon area. Dames & Moore and Modine have concluded that the TCE concentrations encountered in the soil at the lagoon supports their previous position that the former lagoon is the off-site source of the observed TCE impact to groundwater at the Modine facility. DNR RCRA Permits personnel hold the position that the nature, extent and source of the TCE groundwater contamination in the area has not been fully determined yet. That is one of the objectives of the AOC currently being negotiated. At least four waste management units on the 179 Sunset Drive property have been identified as potential contributors to TCE soil and groundwater contamination (Reference 16).

3.2 **PA/SI Sampling** (Reference 38)

PA/SI soil sampling in the lagoon area was conducted on January 21, 1999. Figure 2 is a site map that shows collection location of all soil samples in the lagoon area. A membrane interface probe (MIP), equipped with a PID and a flame ionization detector (FID), was employed to generate soil gas data of the subsurface within and surrounding the boundaries of the former lagoon area.

Ten soil borings (Hulett-01 through Hulett-10) were drilled utilizing a track-mounted

hydraulic soil probe. Eight soil grab samples were collected from the lagoon area and one background sample was collected from outside the lagoon. Based upon this sampling, the lagoon is estimated to have been approximately six feet deep. Previous sampling documented refusal, meaning bedrock was encountered, in drilling from a range of five to six feet below ground surface, depending on the boring location. The PA/SI background boring was drilled approximately 25 feet south of the lagoon's edge. The background sample was collected from a 10.5' to 11' depth, which was a similar depth zone as the majority of the source samples from the lagoon, correcting for the rise in elevation at the background sampling point.

3.3 PA/SI Analytical Results (Reference 38)

Reference 38, Appendix B contains the MIP data logs generated for each boring. The logs indicate detections noted on the MIP's PID (identified as "Detector 1") and the FID ("Detector 2"). There were not any significant detections with the MIP for any of the borings.

Table 2, on page 13, presents the analytical results for all soil samples collected by DNR as part of the PA/SI. All soil samples were analyzed for total metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, and silver) and VOCs. If any sample's total analyte levels exceeded 80% of 20 times the Toxicity Characteristic Leaching Procedure (TCLP) regulatory limit for a particular analyte, TCLP analysis was performed on that sample.

The last column in Table 2 lists the Missouri Cleanup Action Level (CALM) C_{LEACH} level for each chemical. These values were listed for additional comparison. The Superfund Chemical Data Matrix (SCDM) benchmarks and MO Any-Use Soil Levels (ASLs) for chemicals only take into account human health effects related to exposure to the chemicals in the soil. They do not take into account the effect the chemicals have when they leach into the groundwater. The C_{LEACH} value was calculated to approximate the physical processes involved in a soil contaminant leaching to the groundwater. The C_{LEACH} value may be interpreted as a soil contaminant concentration, which (within the limitations of the formulas and assumptions used for calculation) if allowed to remain, would leach to the saturated zone and result in a groundwater concentration at or below the MCLs.

Three soil samples contained TCE at a detectable level. TCE was not detected in the background soil sample. The concentrations of TCE detected in the three samples from the lagoon exceed the C_{LEACH} value for TCE, which would indicate the potential exists for TCE to leach into the saturated zone and result in groundwater contamination above the MCL. This is, in fact, the situation at this site, as documented from groundwater samples collected from the monitoring well on-site (discussed in Section 4.5) (Reference 42).

The only sample that contained any metals significantly above background was 991471 from soil boring 4. Barium and cadmium were over three times the background levels, however neither metal was present above the SCDM benchmarks or MO ASLs.

3.4 Conclusions

Although over 2,000 cubic yards of sludge were removed from the lagoon during closure in 1989, PA/SI sampling, as well as previous sampling, document that TCE contaminated soil still remains in the lagoon area. Three samples, collected for the PA/SI near the previous location of the outfall pipe, contained TCE at 9.5 ppm, 0.24 ppm and 0.12 ppm. These TCE concentrations are below health-based benchmarks protective of human exposure to the soil. However, the concentrations exceed the Missouri CALM C_{LEACH} value, which was calculated as a value at which TCE would leach to the saturated zone and result in a groundwater concentration at or below the MCLs. The C_{LEACH} value for TCE was calculated using specific formulas and assumptions that may not necessarily model site conditions at the Hulett lagoon.

One way of testing whether the TCE present in the soil at the lagoon has the potential to leach into groundwater at a level above the MCL would be to perform the Synthetic Precipitation Leaching Procedure on the soil samples. This may be necessary in future investigations.

TABLE 2: ANALYTICAL RESULTS FROM SOIL SAMPLES COLLECTED IN/NEAR THE HULETT LAGOON

All results in parts per million (ppm) * soil saturation level substituted for ASL NA - not analyzed NL - not listed
Underlined results are those that are three times above background or above the detection limit if the background concentration is below the detection limit

	Hulett-01 4.5' - 5'	Hulett-02 6.5' - 7'	Hulett-03		Hulett-04 7.5' - 8'	Hulett-07 5.5' - 6'	Hulett-09 6' - 7'		Hulett-10 10.5' - 11'	SCDM Bnchmrk	MO ASL	MO CALM CLEACH
			3' - 4'	4.5' - 5.5'								
	991469	991470	991467	991468	991471	991472	991473	991474 (replicate)	991475 (backgrnd)			
METALS												
Arsenic, total	16.1	3.58	13.6	12.5	19.7	17.2	9.68	4.6	10.7	0.0043	11	NL
Barium, total	150	62.4	244	519	750	257	103	132	203	5500	3900	1650
Barium, TCLP	NA	NA	NA	0.442	0.628	NA	NA	NA	NA			
Cadmium, total	0.453	0.254	0.304	0.386	4.52	0.304	<0.2	0.204	0.651	39	28	11
Chromium, total	74.9	31.9	55.5	61.3	68.9	73.3	58.2	39.8	62.7	390	5600	38
Copper, total	39.9	15.7	33.6	37.5	64.3	38.8	6.47	8.56	36.8	NL	NL	NL
Lead, total	116	38.1	118	951	325	80.1	39.1	61.8	94.2	NL	240	NL
Lead, TCLP	<0.025	NA	0.0772	0.143	<0.025	<0.025	NA	NA	<0.025			NL
Mercury, total	0.102	<0.04	0.107	0.139	0.195	0.141	<0.04	<0.04	0.0947	23	17	3.23
Nickel, total	43.3	12.5	49.4	69.6	90.1	36.2	9.76	12.4	32.5	1600	1100	170
Selenium, total	<1	<1	<1	<1	<1	<1	<1	<1	<1	390	280	4.37
Silver, total	<1	<1	<1	<1	<1	<1	<1	<1	<1	390	280	255
VOCs												
Cis-1,2-dichloroethene	0.19	0.14	<0.025	<0.025	<0.025	0.11	<0.025	<0.025	<0.025	780	490*	0.51
Trichloroethene	9.5	0.24	<0.025	<0.025	<0.025	0.12	<0.025	<0.025	<0.025	58	340	0.097

4.0 GROUNDWATER PATHWAY

4.1 Hydrogeologic Setting (Reference 43)

<u>Stratigraphic Units</u>
A stratigraphic column (Table 3 on page 18) has been tabulated based upon the stratigraphy of nearby wells. The youngest bedrock formations beneath the site are expected to be Ordovician-age sediments assigned to the Canadian Series. The Roubidoux Formation consists of dolomite, sandy dolomite, and sandstone. In the Camdenton area, soluble portions of the Roubidoux have generally been removed by dissolution. Nearby well logs indicate that the Roubidoux Formation may have been completely removed by erosion in the vicinity of the site.

Underlying the Roubidoux Formation, the Gasconade Dolomite consists of cherty dolomite and is estimated to be approximately 300 feet thick in the vicinity of the site. A basal unit of the Gasconade Dolomite, known as the Gunter Sandstone Member, commonly separates the Ordovician and Cambrian-age strata. The Gunter Sandstone is approximately 25 feet thick in the Camdenton area.

Cambrian rocks in the Camdenton area were deposited in a complex depositional environment. Camdenton is located near the western margin of a Cambrian-age intrashelf sedimentary basin known as the Central Missouri Basin. To the west lies the north-south trending Lebanon Arch, which consists of carbonate platform rocks, that in some areas, thin over Precambrian highlands. Dramatically different lithologies and abrupt facies changes are depicted in area well logs. In general, more shaly, basinal rocks to the east pinch-out against the Lebanon Arch.

Because of the tectonic setting, Cambrian beds in the Camdenton area are difficult to categorize, and “layer-cake” stratigraphy should not be assumed. The following descriptions are simplified. The upper-most Cambrian unit in the area is the Eminence Dolomite, which consists of approximately 300 – 635 feet of dolomite with minor amounts of chert. The Eminence Dolomite is underlain by about 25 - 230 feet of Potosi Dolomite, which consists of dolomite, chert, and drusy quartz. Beneath the Potosi Dolomite, in descending order, are the Derby-Doerun Dolomite, the shaly Davis Formation, the Bonneterre Formation, and the Lamotte Sandstone. The entire Cambrian section is estimated to be over 1,150 feet thick.

<u>Aquifers</u>
The Ozark Aquifer, which includes all bedrock units above the Cambrian-age Derby-Doerun Dolomite, is the shallowest aquifer beneath site. The Ozark Aquifer is considered exposed at the surface at the Former Hulett Lagoon site. The total thickness of the aquifer is approximately 950 feet. Each of the units which comprise the Ozark Aquifer have individual characteristics that control their water-bearing capabilities; however, in general, the Ozark Aquifer produces good-quality water, with production rates generally proportional to well depth. Extensive pumping of groundwater in the Camdenton area has created a

downward vertical gradient, and the site is located in a groundwater recharge zone.

Because detailed hydrogeologic studies have not been conducted at the site, groundwater flow directions within the bedrock can only be approximated. Prior to pumping of the aquifer, groundwater beneath the site probably flowed westward or northward to discharge areas in the Niangua River valley. Pumping rates at the Camdenton municipal wells are high enough to engulf the site within the cones of depression that surround the municipal wells. The radius of influence of nearby production wells should be determined.

Groundwater flow in the saturated zone is controlled by gradient. According to DGLS geologists, assertions made by Modine's consultants that preferential pathways in the Ozark Aquifer substantially influence flow direction in the saturated zone are incorrect. Water flows downhill; fractures or solution-enlarged channels cannot make water flow uphill. Monitoring well nests are needed to accurately determine the magnitude of the downward vertical gradient. The upper Gasconade Dolomite *may* inhibit the downward migration of contamination. However, fracturing and karst development may have resulted in a local increase in permeability within the otherwise relatively tight upper Gasconade Dolomite.

The Gunter Sandstone is generally highly porous and permeable and is an important source of domestic groundwater supplies in the area. Because the Gunter Sandstone generally yields adequate domestic water supplies, few private wells in the area penetrate the underlying Cambrian Formations. However, municipal wells in the Lake of the Ozarks area are generally cased through the Gunter Sandstone, in order to avoid possible bacterial contamination.

The Eminence and Potosi Dolomites are a major source of municipal drinking water throughout the Ozark area, including the City of Camdenton. The Eminence Dolomite is differentiated from the underlying Potosi Dolomite by the lack of druse. A druse is a rock cavity encrusted with finely crystalline quartz. The druse-rich Potosi Dolomite is the most permeable geologic unit within the Ozark Aquifer and generally has an extensive network of karstic channels.

The shallowest reliable aquitard beneath the site is the St. Francois Confining Unit, approximately 1,200 feet below the surface. The St. Francois Confining Unit separates the Ozark Aquifer from the deeper St. Francois Aquifer. The St. Francois Aquifer includes the Cambrian-age Bonneterre Formation and Lamotte Sandstone. The St. Francois Aquifer is not used as a water source in Camden County. Water losses in the Lamotte Sandstone are common in some parts of the Ozark Region, although the phenomenon is poorly understood. Outside the Cambrian outcrop area, few water wells penetrate the Lamotte Sandstone, since yields may actually be reduced. Groundwater flow directions in the deeper St. Francois Aquifer are generally unknown and may be complicated.

Baseline water-level and pumping rate data needs to be collected before informed decisions about groundwater movement in the Camdenton subsurface can be made.

Static water levels should be measured at least monthly at any inactive wells. Detailed records of active wells should include volume of water pumped, length of pumping cycles, and drawdown measurements. The Mulberry City Well (which was shut down on January 26, 1999 because of TCE contamination) produced approximately three times the volume of the other two city wells, suggesting the aquifer is highly heterogeneous. The Mulberry Well probably intercepted more solution-enlarged cavities than the other city wells, although lithologic differences can also explain differences in well yield. Wide variations in aquifer parameters are common in carbonate areas.

The three Camdenton city wells produced a total of 232,458,000 gallons in 1997. An estimate of the cone of depression produced by this pumping can be made by comparing Camdenton to the city of Rolla, which is located in a similar ridge-top geologic setting approximately 50 miles east of Camdenton. In 1960, four Rolla city wells produced approximately 290,250,000 gallons of water from the Ozark Aquifer. The resulting cone of depression was over five miles wide. By 1960, pumping of the Ozark Aquifer in the Rolla area had dropped water levels up to 150 feet compared to the predevelopment potentiometric surface. The relatively deep depth to groundwater in the Camdenton area suggests a similar radius of effect can be expected. Any potential site-related contaminants reaching the water table are expected to move toward the nearest Camdenton City well. Until recently, hydraulic control beneath the Former Hulett Lagoon and Modine sites has been maintained by pumping at the Mulberry well. Now that the Mulberry well has been shut off, TCE contamination is expected to move toward another city well.

Monitoring wells at the Modine site are open to different depth intervals. Therefore, data from these wells cannot be used to create a potentiometric map. The fact that two of the four wells have gone dry in the past suggests that the vertical flow component is significant. Water levels in area wells tend to decrease with depth, supporting the statement that the vertical flow is downward. As previously mentioned, a downward gradient is to be expected in an active municipal well field, particularly if it is located on a ridge top. Static water levels measured during the construction of the newest Camdenton City well (Hickory Street or well # 7) also verify the downward gradient. The Hickory Street well is 1,100 feet deep with 462 feet of casing. The static water level before pressure-grout sealing of the well casing was 222 feet below ground surface. Static water level after sealing was 260 feet below ground surface, indicating a downward vertical gradient. A large upland area that might provide recharge to the Camdenton City wells does not exist. Groundwater monitored by the monitoring wells is essentially moving downward to recharge the pumping wells. Conclusions about lateral flow directions cannot be made based on water levels from the existing monitoring well network.

It has been suggested that contaminants reaching the saturated zone beneath Camdenton will follow “regional groundwater flow” and discharge at the Lake of the Ozarks. However, groundwater withdrawals averaging over 500,000 gallons per day will create a large cone of depression and obliterate “regional groundwater flow” in any Ozark ridge top setting. A 2-hour pump test of the new Hickory St. well at 550 gallons per minute (gpm) caused a

176-foot drawdown in water level. There is no evidence to suggest that potential contaminants reaching the water table from either the Former Hulett Lagoon or the Modine site can somehow escape the Camdenton well field.

Aquifer Discontinuities
Minor folds and faults in the area cannot be considered aquifer discontinuities. However, it should be noted that the Cambrian-age formations that form the most productive portions of the Ozark Aquifer beneath the site are highly variable in lithology. The aquifer cannot be considered isotropic, nor does it possess radial symmetry. Aquifer parameters may be so variable as to render groundwater modeling useless.

Wellhead Protection Area
Camdenton is located in Area 1, as designated by the DGLS Wellhead Protection Section. Since September 1987, Area 1 bedrock wells have been required to have 80 feet of casing and penetrate at least 30 feet of bedrock. Wells within ¼ mile of the Lake of the Ozarks are located in Sensitive Area B and subject to additional requirements.

Karst Features
The Camdenton area is considered karst. Significant karst features are present within a four-mile radius of the site. When MW-5 was drilled at the site, numerous fractures and small voids were encountered. Over 5,000 gallons of water was lost during the drilling of the monitoring well.

4.2 Groundwater Targets

Groundwater use within four miles of the site is extensive. At least 3,420 people are served by public wells in the area and an estimated 409 people are served by private wells. A detailed description of the well use follows.

Public Drinking Water Wells
The City of Camdenton currently utilizes three wells to supply drinking water to city residents: the Rodeo Grounds well, the Blair Heights well, and the Hickory well. The city also has a fourth well, the Mulberry well, that was taken off line on February 2, 1999 due to TCE contamination. The Mulberry well is currently used only as a standby well when any of the other three wells are not operating. Since February 2, 1999, the Mulberry well has been on-line twice. Due to electrical problems at the Blair well, Mulberry well was pumped from February 2 to the 9th, for a total of about 400,000 gallons. Due to problems with the water controls, Mulberry well was pumped from February 12 - 16th, for a total of 1,314 gallons (References 44; 45).

Table 3: Stratigraphic Column for Former Hulett Lagoon, Camden County (after Harvey et. al.,1983)

System	Aquifer Group	Approximate Site – Specific Thickness (ft)	Formation	Hydraulic Conductivity (cm/sec)	Regional Thickness (ft)	Dominant Lithology	Water-bearing Character
Quaternary		8	Colluvium and residuum		0-90	Regolith of residual clay, sand, chert pebbles and cobbles	May contain small amounts of perched water.
Ordovician	Ozark Aquifer	0?	Roubidoux Formation	10^{-3}	0-90	Clayey residuum, sandstone and sandy dolomite	Not present in sufficient thickness in the Camdenton area to produce usable quantities of water.
		300	Gasconade Dolomite	10^{-6}	300-385	Cherty dolomite, minor sandstone, and shale	Yields moderate to large quantities of water to wells. Yields range from 20 to 75 gpm. Less-permeable Upper Gasconade may act as a leaky confining unit.
		25	Gunter Sandstone Member	10^{-4}	10-45	Sandstone	Contributes moderate to large quantities of water. Most wells open to other formations.
Cambrian		500?	Eminence Dolomite	10^{-5}	240-600?	Cherty dolomite	Yields 6-100 gpm, the average being about 20 gpm
		150?	Potosi Dolomite	10^{-4}	30-330	Dolomite; contains abundant quartz druse	Yields large quantities of water to wells. Yields range from 100 to 750 gpm.
	St. Francois Confining Unit	180	Derby-Doerun Dolomite	10^{-7}	80?-215	Shaley dolomites and shale	Reliable aquitard.
		80	Davis Formation	10^{-7}	50-380?		
	St. Francois Aquifer	160	Bonneterre Formation	10^{-5}	85-200	Dolomite and limestone	Generally used only in outcrop areas. May contribute additional 100-200 gpm to wells open to other formations.
		240	Lamotte Sandstone	10^{-5}	140-300	Sandstone and arkosic conglomerate	
Precambrian	Basement Confining Unit					Igneous and metamorphic rocks	Does not yield water to wells in this area

The Rodeo well is located on Rodeo Road, just over one mile southeast of the site. The Rodeo well was drilled in 1961 to a total depth of 940 feet with 450 feet of eight-inch steel casing. The pump is set at 420 feet. The yielding strata is the Potosi Dolomite of the Ozark Aquifer. Records show the well yields 380 gpm (Reference 44).

The Blair Heights well is located on Lakeview Drive, 0.7 of a mile south-southwest of the site. The Blair well was drilled in 1974 to a total depth of 1060 feet with 400 feet of ten-inch diameter steel casing. The pump is set at 450 feet. The yielding strata is the Potosi Dolomite of the Ozark Aquifer. Records show the well yields 100 gpm (Reference 44).

The Hickory well is located at the southwest end of Hickory Street, 0.8 of a mile east of the site. The Hickory well was drilled in 1998 to replace the Mulberry well. The Hickory well was drilled to a total depth of 1100 feet with 450 feet of eight-inch diameter steel casing. The pump is set at 500 feet. The yielding strata is the Potosi Dolomite of the Ozark Aquifer (Reference 44).

The Mulberry well is located south of Mulberry Lane, 0.25 of a mile south of the site. The Mulberry well was drilled in 1986 to a total depth of 900 feet with 400 feet of twelve-inch diameter steel casing. The pump is set at 350 feet. The yielding strata is the Potosi Dolomite of the Ozark Aquifer. Records show the well yields 600 gpm (Reference 44).

When in use, the Mulberry well was blended with the other two wells, with the Mulberry well being the largest producer. The City of Camdenton's Public Works Director reported that the Mulberry well was the lead well until July 1998. Before July 1998 the controls on the wells were set such that Mulberry well was always the first to run; the Blair and Rodeo wells only ran when the Mulberry well was not able to handle the demand. During that time, the Mulberry well supplied about 70% of the water to the system. New controls were installed in July 1998, and the city was able to set the time the wells came on. In response to the TCE contamination showing up in the well, the Mulberry well was set as the third well to come on. With the new controls the Mulberry well was cut back to supply only about 40% of the water to the system (Reference 45). The City of Camdenton's water supplies a total of 3,010 people (Reference 46, p. 14).

The Windsor Estate Nursing Home well is located on Highway 5, approximately 1.4 miles northwest of the site. The well was drilled in 1969 to a total depth of 600 feet with 400 feet of six inch casing (Reference 61). This well serves 70 people (Reference 32, p. 131).

The Linn Creek well is located on Highway 5, approximately 2.9 miles northeast of the site. The well was drilled in 1984 to a total depth of 860 feet with 528 feet of six inch steel casing (Reference 62). This well serves 260 people (Reference 32, p. 33).

The Southway Terrace Mobile Home Park well is located on Highway 5, 2.3 miles northwest of the site. The well was drilled in 1970 to a total depth of 550 feet with 350 feet of six inch steel casing (Reference 63). This well serves 85 people (Reference 32, p. 120).

TABLE 4: PUBLIC WELLS WITHIN A 4-MILE RADIUS OF THE FORMER HULETT LAGOON SITE		
Distance from Site	Name of Well	No. of People Served*
0 - 1/4	City of Camdenton's Mulberry Well	2,107†
1/2 - 1	City of Camdenton's Blair Well	1,003‡
	City of Camdenton's Hickory Well	1,003‡
1-2	City of Camdenton's Rodeo Well	1,003‡
	Windsor Estate Nursing Home	70
2-3	Linn Creek	260
	Southway Terrace MHP	85
TOTAL		3,425

* Reference 46, pp. 14, 33, 120, 131
† This represents the number of people apportioned to this well when it was in peak operation during the initial time period when TCE was detected in the well
‡ This represents the current situation in Camdenton without the Mulberry well operating

There are several drinking water wells within a four-mile radius of the site that are classified as transient, non-community water systems. They include mostly resorts and restaurants in the Lake of the Ozarks area. These wells, by definition, serve at least 25 different people at least 60 days out of the year (Reference 47). However, the number of people served by these wells will not be included in a count of potential targets due to the transient nature of the population.

Private Drinking Water Wells

Within four miles of the site, there are over 485 wells recorded in the DGLS databases. The LOGMAIN database contains information on older wells. The DGLS Well Wellhead Protection Section's Water Well Information System (W.I.M.S) database contains information on wells drilled since 1987. The vast majority of the wells on record are domestic supply wells. Some wells may no longer be active, and many active wells may not be recorded in DGLS databases. Table 5 illustrates the breakdown of private wells within four miles of the site (Reference 43). The population served by private wells was calculated using the estimated average persons per household in Camden County - 2.41 (Reference 48).

TABLE 5: PRIVATE WELLS REGISTERED WITH DNR WITHIN A 4-MILE RADIUS OF THE FORMER HULETT LAGOON SITE		
Distance From Site	Number of Private Wells	Estimated Population Served
0 - 1/4	1	2
1/4 - 1/2	-	-
1/2 - 1	2	5
1-2	27	65
2-3	59	142
3-4	81	195
TOTAL	170	409

4.3 Previous Sampling

Monitoring Wells

Modine Manufacturing Company has performed quarterly sampling of the monitoring wells on their site. The TCE concentrations in the monitoring wells are detailed in the table below (Reference 49).

TABLE 6: TCE CONCENTRATIONS IN MODINE GROUNDWATER MONITORING WELLS 1 - 5
All results in parts per billion
NT - Not tested ND - Not detected at or above 5 ppb NS - Not sampled due to insufficient volume

Date of Sampling	MW-1	MW-2	MW-3	MW-4	MW-5
09/02/92	ND	ND	These wells were not drilled until 1995.		This well was not drilled until 1998.
12/07/94	6.9	5.1			
08/16,22/95	11.8	ND	8	88.9	
11/16/95	9.4	ND	ND	142	
02/15,16/96	ND (duplicate 5.4)	ND	6.6	173	
05/16/96	ND	ND	ND	10	
08/20/96	ND	NT	ND	NS	
12/12/96	ND	NT	NS	NS	
02/28/96, 03/0397	NT	NT	ND	34	
06/04/97	NT	NT	NT	120	
07/16/98	These wells were not sampled at this time. This was during the installation of MW-5.				484.1

Public Drinking Water

Table 7, on the following page, shows the history of TCE detections in the City of Camdenton's public drinking water wells. The first time TCE showed up in the Mulberry well was in March of 1993. The sample was collected by the Missouri Department of Health and analyzed at Continental Analytical Services, Inc. (Reference 50).

The DNR requires public drinking water wells be tested for volatile organic compounds every three years. DNR mails sampling containers to the public water supply office, and then a designee, in the City of Camdenton's case, the Public Works Director, collects the sample and sends it to DNR for analysis. When a contaminant is detected, sampling frequency is then increased to quarterly and sometimes monthly. If the running annual average concentration of the contaminant exceeds the MCL, the public system is in violation of the drinking water standard.

The first sample analyzed by DNR in which TCE was detected at the Mulberry well was in January 1997. During sampling in 1997, there was only one sample that exceeded the MCL (February's sample was 5.2 ppb), but the running annual average for that year was below the MCL. In 1998, the levels of TCE began to increase (Reference 50). At that time, the city began looking at options to replace the Mulberry Well. In May 1998, the city announced they were in the process of planning for a new well to be drilled on Hickory Street to replace the Mulberry Well (Reference 51). In addition, in July 1998, the City of Camdenton installed new regulating controls on their drinking water wells that allowed them

to cut back the usage of the Mulberry Well. It went from supplying about 70% of the water when blended with the other two wells, to supplying about 40%. In February 1999, the new Hickory well went on line and the Mulberry well was shut off (Reference 45).

TABLE 7: TCE RESULTS FROM SAMPLING AT CITY OF CAMDENTON'S PUBLIC DRINKING WATER WELLS
Results in parts per billion

Date of Sampling	Mulberry Well	Rodeo Well	Blair Well
03/16/93	2.1	<0.5	<0.5
04/27/94	<0.5	<0.5	<0.5
01/29/97	3.8	3.9*	<0.5
02/17/97	5.2	<0.5	<0.5
03/12/97	3.8	<0.5	<0.5
06/03/97	4.5	<0.5	<0.5
08/26/97	4.3	<0.5	<0.5
12/01/97	4.4	<0.5	<0.5
02/02/98	6.3	<0.5	<0.5
02/17/98	5.2	<0.5	<0.5
03/25/98	3.6	<0.5	<0.5
04/23/98	4.1	<0.5	<0.5
05/21/98	11.8	<0.5	<0.5
06/08/98	5.1	<0.5	<0.5
08/25/98	4.2	<0.5	<0.5
12/02/98	4.4	<0.5	<0.5
01/13/99	26.2	<0.5	<0.5

* The Rodeo well is over one mile from the Hulett lagoon. It is unknown whether this TCE detection was a valid result, especially since all subsequent samples were non-detect for TCE.

<u>Private Wells</u>

On April 23, 1998, DNR collected a groundwater grab from a private well at 178 Sunset Drive. The sample was analyzed for VOCs. Cis-1,2-dichlorethene was detected at 12 ppb and TCE was detected at 210 ppb. At that time, the owner was using the well only for lawn watering; the home was hooked up to the city water line for drinking water (Reference 52).

In July 1992, as part of the SI conducted at the 179 Sunset Drive facility, three samples were collected from private wells located near the Lake of the Ozarks. Two of the wells were located in Normac Estates, 1.8 miles west-southwest of the site. The third well was located 1.3 miles southwest of the site. No VOCs were detected in any samples (Reference 36).

4.4 Sampling Locations

Groundwater samples for the PA/SI were collected on January 6-7, 1999. Five monitoring wells, two public water supply wells, and two private drinking water wells were sampled.

Figure 3 shows sample locations for all groundwater samples collected as part of the Hulett Lagoon PA/SI (Reference 38).

Monitoring Wells 1 & 2
Layne-Western Company, Inc., was subcontracted by DNR for the installation of Monitoring Wells #1 and #2 on the Modine Manufacturing Company property (then known as Modine Heat Transfer). The wells were installed in July 1992 during the SI performed at the 179 Sunset Drive facility. MW-1 is located on the west side of the facility. MW-2 is located northeast of the facility. Total well depth of MW-1 was 178 feet and MW-2 was 197 feet. The wells were constructed with two-inch diameter, polyvinyl chloride (PVC) inner well casing, with steel outer well casing. Both wells have 40 feet of screen at the bottom of the well (References 36; 53).

On January 7, 1999, sample 991464 was collected from MW-1 and sample 991463 was collected from MW-2. Depth to water recorded at 153.2 feet from the top of the casing in MW-1. Depth to water recorded at 165.7 feet from the top of the casing in MW-2 (Reference 38).

Monitoring Wells 3 & 4
Layne-Western Company, Inc. of St. Louis was subcontracted by Dames & Moore, consultant for Modine Manufacturing Company, for the installation of Monitoring Wells #3 and #4. Drilling took place from August 8-14, 1995. MW-3 was installed on August 8, 1995, south of the Modine facility. MW-4 was installed on August 11, 1995, just northwest of the facility. MW-3 is 167 feet deep with 64 feet of five-inch diameter steel surface casing. MW-4 is 158 feet deep with 44 feet of five-inch diameter steel surface casing. Both wells are open hole below their casing (Reference 54, p. 35).

On January 7, 1999, sample 991460 was collected from MW-3 and samples 991461 and 991462 were collected from MW-4. Sample 991461 was collected via a submersible pump and 991462 was collected via dedicated bailer. The two different methods for collection were used for comparison purposes. All other groundwater samples from monitoring wells were collected with a dedicated bailer. Depth to water recorded at 153.1 feet from the top of the casing in MW-3. Depth to water recorded at 158.5 feet from the top of the casing in MW-4 (Reference 38).

Monitoring Well 5
Layne-Western Company, Inc. of St. Louis was subcontracted by Dames & Moore, consultant for Modine Manufacturing Company, for the installation of Monitoring Well #5. The well was installed just outside what would have been the southwest edge of berm of the Hulett lagoon. Drilling took place from July 7-10, 1998. The well was installed to determine the presence or absence of volatile organic compounds, in particular, TCE, in the groundwater underlying the former Hulett lagoon. The well was drilled to a total depth of 118 feet below ground surface (bgs). Permanent surface casing was installed in bedrock to a depth of 37 feet bgs. This was done to case off several void spaces that had been encountered during drilling, most notably a void space from 35.0 to 36.5 feet bgs.

The well was constructed with schedule 80, two-inch diameter, PVC casing with 30 feet of a 0.01 inch slotted screen. Water was encountered at a depth of 105 feet bgs (Reference 55).

On January 7, 1999, samples 991465 and 991466 (duplicate) were collected from MW-5. Depth to water recorded at 102.7 feet from the top of the casing in MW-5 (Reference 38).

Public Wells
Sample #991458 was collected from the City of Camdenton Blair well. The Blair well was considered a background well for PA/SI purposes since previous sampling has shown this well not to be contaminated. However, groundwater flow direction has not been definitively determined; the cones of depression created by the city's wells could significantly affect groundwater flow in the area. Sample #991459 was collected from the City of Camdenton Mulberry well, known to be contaminated with TCE (Reference 38).

Private Wells
Sample 991452 and 991453 (a duplicate) were collected from a residential well, located at 178 Sunset Drive, approximately 790 feet southwest of the site. This well is currently not used for any purpose. When the well was sampled in April 1998 and found to be contaminated with TCE, the owner discontinued use, which at that time was only for watering his lawn. No information is known about the well (Reference 38).

Sample 991457 was collected from a residence in Normac Estates, located 1.8 miles west-southwest of the site on the lakefront of the Lake of the Ozarks. No information is known about the well (Reference 38).

4.5 Analytical Results (Reference 38)

All groundwater samples for the PA/SI were analyzed for total and/or dissolved metals (arsenic, barium, cadmium, chromium, copper, mercury, nickel, lead, selenium, silver), and VOCs. The analytical results for all groundwater samples are detailed in the tables on the following page.

Monitoring Wells

TABLE 8: SELECTED GROUNDWATER RESULTS FROM PA/SI SAMPLING AT MODINE MONITORING WELLS 1 - 5

All results in parts per billion   NA - not analyzed
* 991461 was collected via submersible pump, 991462 was collected via dedicated bailer
Bolded results are those above the EPA MCL.

CHEMICAL	MW-1	MW-2	MW-3	MW-4		MW-5		EPA
	991464	991463	991460	991461*	991462*	991465	991466	MCL
METALS								
Arsenic, total	<1.2	<1.2	6	<1.2	NA	<1.2	<1.2	50
Barium, dissolved	49.7	91	69.6	81.6	NA	55.7	51.6	2000
Barium, total	58.2	112	151	88.3	NA	67.9	71.3	
Cadmium, total	<1.0	<1.0	2.26	<1.0	NA	1.25	1.97	5
Chromium, total	3.84	14.3	45.7	5.52	NA	9.39	13.3	100
Copper, total	6.94	7.85	51.2	<5.0	NA	7.52	8.97	1300
Nickel, total	<3.0	8.45	29.7	7.61	NA	5.16	4.26	100
Lead, total	14.1	**37.2**	**97.6**	**38.7**	NA	12.7	**15.3**	15
VOCs								
Cis-1,2-dichloroethene	<0.5	<0.5	<0.5	2.1	2.3	35	23	70
Trichloroethene	**10.1**	2.5	<0.5	**64.1**	**76.5**	**1400**	**1500**	5

For purposes of the PA/SI and according to HRS guidelines, any of MW's 1 through 4 could be considered background for the MW-5. Although previous and current sampling has shown that MW's 1 through 4 have been, or presently are, within the boundaries of the TCE plume, the TCE contamination in MW-5 exceeds three times the TCE concentration in any of the other monitoring wells. Additionally, however, all five monitoring wells are not entirely similar in construction. MW's 3 and 4 are open hole borings below their casing, while MW's 1, 2 are screened for 40 feet; MW-5 is screened for 30 feet. MW-1 is 60 feet deeper than MW-5; and MW-2 is 79 feet deeper than MW-5. Although the intervals from which water is drawn in the monitoring wells is not entirely similar, all five wells draw water from the Gasconade Dolomite formation of the Ozark Aquifer.

Public and Private Drinking Water Wells

TABLE 9: SELECTED GROUNDWATER RESULTS FROM PA/SI SAMPLING AT PUBLIC AND PRIVATE GROUNDWATER WELLS

All results in parts per billion

CHEMICAL	Camdenton Blair Well (Background)	Camdenton Mulberry Well	Sunset Drive Private Well		Normac Estates Private Well	EPA MCL
	991458	991459	991452	991453	991457	
METALS						
Barium, total	45.3	45.3	67.5	66.6	62.8	2000
Copper, total	21.7	31.7	27.5	16.3	44.7	1300
Nickel, total	<3.0	<3.0	11.2	60.4	<3.0	100
Lead, total	4.4	**15.7**	<2.5	<2.5	<2.5	15
VOCs						
Cis-1,2-dichloroethene	<0.5	<0.5	13	13	<0.5	70
Trichloroethene	<0.5	**5.3**	**240**	**230**	<0.5	5

For purposes of the PA/SI, the Camdenton Blair well was chosen as a background well for the contaminated Mulberry well. The two wells are similar in total depth and both draw from the Potosi Dolomite formation of the Ozark Aquifer. The Mulberry well could in fact serve as its own background since the well was regularly monitored as a public well under Missouri regulations, and was non-detect for TCE until 1997 (except for one sample in 1993 collected by the Missouri Department of Health).

4.6 Conclusions

PA/SI sampling has documented an observed release of TCE to the Ozark Aquifer in the area of the Former Hulett Lagoon site. MW-5, located immediately near the lagoon, contained TCE at 1,400 ppb. The City of Camdenton's Mulberry well, located less than 0.25 of a mile south of the lagoon showed 5.3 ppb TCE during PA/SI sampling on January 6, 1999.

The City of Camdenton officially took the Mulberry Well off line on February 2, 1999 due to the TCE contamination. When in use during the initial time period when TCE was detected, the Mulberry Well was the highest producing well of Camdenton's system, supplying an apportioned 2,107 people. The well is now a reserve well, to be used only when power is down at any other Camdenton Wells. There are three wells currently serving the city within two miles of the site. The City of Camdenton's drinking water wells supply an estimated 3,010 people.

There are two sources of TCE that could be attributed to the contamination present in the City of Camdenton's Mulberry Well. PA/SI sampling has shown the former Hulett lagoon contains TCE contaminated soil, as well as groundwater, at the lagoon site. The lagoon is located approximately 1100 feet north of the Mulberry well. The manufacturing facility at 179 Sunset Drive has also been shown to contain TCE contaminated soil as well as TCE contaminated groundwater. The facility is located approximately 500 feet northwest of the Mulberry Well. It is unknown at this time whether the Mulberry Well contamination is due in whole or in part to the lagoon contamination. Information on groundwater flow direction is inconclusive. DNR's DGLS geologists suggest that the cone of depression created by the Mulberry well, when in operation, influenced groundwater flow in that direction. Now that the Mulberry well has been shut off, groundwater flow is expected to move toward another city well, most likely the Blair well.

5.0 SURFACE WATER PATHWAY

5.1 Hydrologic Setting

The site is situated within the Salem Plateau region of the Ozark Plateau physiographic province. The topography of the Salem Plateau is characterized by a rolling upland surface with rugged hills dissected by entrenched, narrow stream valleys. Karst features, such as springs, sinkholes, and losing streams, are characteristic of the Salem Plateau (Reference 43).

The Former Hulett Lagoon site is situated near the headwaters of a small unnamed stream which drains southwest to the Niangua Arm of the Lake of the Ozarks. During operation, the Hulett lagoon's receiving stream was identified as a tributary to Jarvis Hollow. The site of the former lagoon has been leveled, while the surrounding terrain exhibits moderate natural relief (5% to 9% slopes). East of the site lies the City of Camdenton. West of the site, the landscape is more rugged, and forests extend down to the Lake of the Ozarks. The natural landforms and drainage patterns at the site have been obscured by lagoon construction and, later, by soil removal actions (Reference 43).

Below the site, the receiving stream is fairly steep and the bedload consists mostly of cobbles and gravel. In 1992, a DGLS geologist with the Water Resources Program examined area streams as part of oversight for an investigation at the 179 Sunset Drive facility. He reported that the Former Hulett Lagoon site is located on the valley floor of the “northeast branch” of an unnamed tributary to Jarvis Hollow. The “southeast branch” of the tributary drains the facility at 179 Sunset Drive. The northeast and southeast branches join near the western corporate boundary of the City of Camdenton, approximately 0.6 miles downstream of the Former Hulett Lagoon site. The lagoon was constructed near the headwaters of the northeast branch, just west of the ridge top where most of Camdenton is located. Water runs onto the site from the upper section of the northeast branch. This channel has been diverted around the northern edge of the former lagoon (Reference 43).

Run-off from the site, entering the northeast branch, flows toward the west for ¼ mile. Runoff then flows southwest approximately 1.6 miles and enters Jarvis Hollow in the NE ¼, NE ¼, SE1/4 of Section 34, Township 38 North, Range 17 West. According to the 7.5 minute HaHaTonka topographic map, the 0.15-mile-long stream segment below this confluence appears to be perennial. Thus, the confluence of the unnamed tributary and the stream in Jarvis Hollow is considered the probable point of entry (PPE) to surface water. Runoff from the Former Hulett Lagoon reaches the Lake of the Ozarks 1.97 miles downstream of the site (Reference 43).

The DGLS geologist noted that the unnamed tributary lost flow in some locations, especially when encountering the Gunter Sandstone. However, it was anticipated that any flow lost in the streambed would stay in the valley. Very little rainfall is necessary to generate surface flow throughout the reach of the stream. The receiving stream for the Former Hulett Lagoon Site has not been officially classified by DGLS, but based on available reports, the stream should be considered losing. The Gasconade Dolomite that forms much of the streambed is not particularly karst. Many nearby streams have been classified as losing (Reference 43).

The 15-mile downstream limit ends near Shepard Cove on the Osage River Arm of the Lake of the Ozarks, approximately 29.5 miles above Bagnell Dam. This point is located on the Camdenton, MO 7.5-minute quadrangle; SE ¼, Section 24, T. 39 N., R. 17 W. The Osage River flows in a northeasterly direction, toward the Missouri River (References 43; 3).

The site is most likely not located in a flood plain, as it is located at an elevation of approximately 285 meters above mean sea level, while Lake of the Ozarks is at 198 meters above sea level (Reference 3).

5.2 Surface Water Targets

The Lake of the Ozarks is a 59,520 acre lake classified as a major reservoir. The lake is designated for use as livestock and wildlife watering, protection of warm water aquatic life and human health/fish consumption, whole body contact recreation, and boating and canoeing (Reference 56, pp. 11, 35). There are no drinking water intakes on the Lake of the Ozarks (Reference 46, p. 200).

The federally-listed Endangered gray bat is known to occur on the Lake of the Ozarks in Section 2 of T 38 N, R 18 W. The bats forage over streams, rivers, and reservoirs in this part of Missouri (Reference 57).

The federally-listed threatened Bald Eagle winters at the Lake of the Ozarks. Bald eagles generally forage on fish, dead and dying waterfowl, and carrion. Eagles can be adversely affected by heavy metals, bacteria, and other contaminants. Due to the scavenger behaviors of the eagle, they often feed on dead or dying prey that may have been poisoned in some way or may have elevated bacterial levels. In such cases, eagles can be affected through a secondary pathway in the food chain which could harm or kill individuals (Reference 58).

According to National Wetlands Inventory maps prepared by the U.S. Department of the Interior/Fish and Wildlife Service (aerial photography from 1984), the first 0.6 of a mile of the creek bordering the lagoon is a wetland. The remaining portion of the creek leading to the Lake of the Ozarks may be considered a wetland if emergent hydrophytes are present. There are numerous wetlands in and bordering the Lake of the Ozarks (Reference 59).

5.3 Surface Water Conclusions

All surface runoff from the lagoon area enters the tributary to Jarvis Hollow stream that borders the west side of the lagoon. This stream received overflow from the lagoon during operation; thus TCE was historically released to the creek. However, the stream bed near the site is gravel, making sampling impractical. It has been ten years since the lagoon was closed; it is unlikely any TCE would be left in any surface material, soil or sediment, present in other parts of the stream. Since TCE is a DNAPL, the majority of what entered the stream would have infiltrated into the subsurface by now. Current site conditions indicate the risk from any site surface runoff would be low since the TCE found in the soil at the lagoon was from the four to seven foot depth.

6.0 SOIL EXPOSURE AND AIR PATHWAYS

6.1 Physical Conditions

The native soil in the vicinity of the Former Hulett Lagoon site was the Clarksville-Gepp very cherty silt loam. The Clarksville-Gepp soils are deep, well-drained soils typical of sloping uplands. Permeability is moderate. The content of organic material is moderately low. The shrink-swell potential is moderate. Grass at the site limits wind erosion (Reference 43).

The one acre former lagoon area is an open field area with grassy vegetation. The only structure on-site is Monitoring Well #5, located on the southwest corner of the lagoon's former berm. The lagoon area is relatively flat. During closure, the majority of the sludge was removed and the berms were turned into the middle. Apparently, some of the material from the hill bordering the southeast and east side of the lagoon was scraped in toward the lagoon during closure, but no fill was brought in (Reference 5).

Access is not restricted to the site; there is no fencing. The gravel access road from West Mulberry is not maintained; there are several severe ruts caused from washouts. There have been reports that illegal dumping is occurring on Ron Hulett property along the north and south side of the access road. There were a few pieces of trash in the lagoon area (Reference 5).

6.2 Soil and Air Targets

Residential areas are located immediately north and south of the site. North of the site is an apartment complex; south of the site is one apartment building and several homes. At least two of the apartment buildings in the complex north of the site are within 200 feet of the site, as well as the apartment building and one home south of the site (Reference 5).

The City of Camdenton has an estimated population of 2,544 people (Reference 48, p. 144). Table 10, on the following page, illustrates the breakdown of the number of people estimated to be within a four-mile radius of the site (Reference 60).

TABLE 10: ESTIMATED POPULATION WITHIN A 4-MILE RADIUS	
RADIUS	POPULATION
ON-SITE	0
0 - 1/4	180
1/4 - 1/2	696
1/2 - 1	1,267
1 - 2	1,100
2 - 3	1,280
3 - 4	1,405
TOTAL	5,928

The federally-listed Endangered gray bat is known to occur in Section 2 of T37N, R17W, which is between 2 and 3 miles from the site (Reference 57).

6.3 Soil and Air Conclusions

All soil samples collected as part of the PA/SI were waste/source samples. The TCE contamination in the lagoon is documented in the four to seven foot depth zone. There were no surface soil samples collected from the lagoon area because the majority of the sludge in the lagoon was removed and the majority of TCE near the surface would have volatilized or moved down through the soil profile in the ten years since closure of the lagoon. The potential for possible trespasser exposure to any of the TCE contaminated soil on the site is considered minimal. There are no people living on site, although there are three apartment buildings and one home that are within 200 feet of the site. Access to the site is not restricted. The reports of unauthorized dumping in the area near the lagoon indicate site security may be warranted.

7.0 SUMMARY AND CONCLUSIONS

The Former Hulett Lagoon site is located in the City of Camdenton, 500 feet northeast of the intersection of Dawson Road and Sunset Drive. The site is a closed wastewater lagoon owned and operated by the City of Camdenton. The Hulett lagoon, approximately one acre in size, was one of five municipal lagoons that serviced the City of Camdenton. It was the only lagoon that received industrial effluent in addition to domestic sewage. The lagoon was in operation from 1961 until its closure in late 1989.

From 1967 through 1986, Dawson Metal Products (1967 to 1972) and Sundstrand Tubular Products (1972 to 1986) operated a manufacturing facility that released untreated wastewater into the lagoon. The facility is located approximately 1000 feet southeast of the lagoon at 179 Sunset Drive. The untreated wastewater was known to have contained

several hazardous waste streams, most notably TCE. During closure in 1989, over 2,000 pounds of sludge was removed from the lagoon.

Environmental investigations of the manufacturing facility at 179 Sunset Drive started in 1990 when Modine Manufacturing Company was considering buying the property. About that time DNR received a complaint alleging that 4,500 gallons of TCE had been spilled at the facility. Since that time, there have been numerous investigations conducted at the 179 Sunset Drive facility, including a PA and SI conducted by DNR. The current owner, Modine Manufacturing Company, is presently negotiating a Resource Conservation and Recovery Act (RCRA) Corrective Action Abatement Order on Consent (AOC) through the Permits Section of DNR's HWP. The AOC calls for investigation to determine the nature and extent of contamination on the facility property. However, investigation of the Hulett Lagoon could not be included in the AOC due to a RCRA domestic sewage exemption. Thus, the Former Hulett Lagoon site was referred to Superfund to be addressed under CERCLA.

Waste/Source Sampling

Although over 2,000 cubic yards of sludge were removed from the lagoon during closure in 1989, PA/SI sampling, as well as previous sampling, document that TCE contaminated soil still remains in the lagoon area. Three samples, collected for the PA/SI near the previous location of the outfall pipe, contained TCE at 9.5 ppm, 0.24 ppm and 0.12 ppm. With such high levels of TCE documented in groundwater at the site (1,400 ppb), it is presumed that the majority of TCE, once deposited in the lagoon, has infiltrated into the bedrock. However, the TCE contaminated soil that remains in the lagoon may be a continuing source of contamination.

Groundwater

PA/SI sampling has documented an observed release of TCE to the Ozark Aquifer in the area of the Former Hulett Lagoon site. MW-5, located immediately near the lagoon, contained TCE at 1,400 ppb. The City of Camdenton's Mulberry well, located less than 0.25 of a mile south of the lagoon showed 5.3 ppb TCE during PA/SI sampling. The Mulberry well was taken off line on February 2, 1999 due to the TCE contamination. When in use during the initial time period when TCE was detected, the Mulberry Well was the highest producing well of Camdenton's system, supplying an apportioned 2,107 people. There are three wells currently serving the city within two miles of the site. It is estimated that the TCE groundwater plume will begin moving toward the city's Blair well now that the Mulberry well has been shut off. The cone of depression created by pumping the Blair well, located 0.7 of a mile south-southwest, may influence the migration of the plume. The City of Camdenton's drinking water wells supply an estimated 3,010 people.

In addition to the Hulett lagoon, there is another source of TCE contamination that could be contributing to the groundwater plume that affected the City of Camdenton's Mulberry well. The manufacturing facility at 179 Sunset Drive has also been shown to contain TCE contaminated soil as well as TCE contaminated groundwater. The facility is located approximately 500 feet northwest of the Mulberry Well. It is unknown at this time whether

the Mulberry Well contamination is due in whole or in part to the lagoon contamination.

<u>Surface Water</u>
All surface runoff from the lagoon area enters the tributary to Jarvis Hollow stream that borders the west side of the lagoon. This stream received overflow from the lagoon during operation; thus TCE was historically released to the creek. However, the streambed near the site is gravel, making sampling impractical. It has been ten years since the lagoon was closed; it is unlikely any TCE would be left in any surface material, soil or sediment, present in other parts of the stream. Current site conditions indicate the risk from any site surface runoff would be low since the TCE found in the soil at the lagoon was from the four to seven foot depth.

<u>Soil and Air</u>
The potential for possible trespasser exposure to any of the TCE contaminated soil on the site is considered minimal. There are no people living on site, although there are three apartment buildings and one home that are within 200 feet of the site. Access to the site is not restricted. The reports of unauthorized dumping in the area near the lagoon indicate site security may be warranted.

8.0 RECOMMENDATIONS

The TCE groundwater contamination at the Former Hulett Lagoon site warrants remedial action. The contamination has already caused the closure of the one of the city's public drinking water wells, and the remaining wells are now at risk. Hydraulic control will need to be achieved at the source of the plume to prevent the migration of TCE to the other nearby wells, specifically the Blair well. Current investigation and remedial actions are ongoing at the 179 Sunset Drive facility, however, these activities do not include and will not address the Hulett lagoon contamination.

Although the majority of the sludge from the lagoon was removed, TCE contaminated soil remains. This contaminated soil may warrant removal. At a minimum, access to the site should be restricted.

Using the Hazard Ranking System (HRS) to evaluate site conditions, the Former Hulett Lagoon site scores above 28.5 and qualifies for proposal to the National Priorities List (NPL). The closing of a public drinking water supply well due to contamination from the site is a significant factor in this site evaluation.

Former Hulett Lagoon
Combined PA/SI
March 30, 1999

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